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VOL. XIII. NEW YORK, JAN. 19, 1889. No. 3.

The New Edison Stations. No article in our pages this week will be read with more interest than that which deals with the two new uptown Edison stations in New York City. The stations in question bear witness to the wonderful development in the practice of electrical engineering, and present many ingenious methods of overcoming novel difficulties and meeting new conditions. Central station construction is, in fact, an art in itself, and the more the details of these stations are studied the more will it be realized that they represent brain and experience, as well as money.

The Electric Discharge. THE literature of the nature of the spark discharge under various conditions has received a decidedly valuable and interesting addition in the paper read before the American Institute of Electrical Engineers by Mr. E. G. Acheson, and published by us this week, together with the discussion thereon. On a close perusal of Mr. Acheson's paper, it will be noted that his conclusions differ somewhat from those arrived at by Dr. Lodge in his celebrated experiments of the alternative path, and he cites several good points to prove the correctness of his theory. Dr. Lodge, it will be remembered, assigns the origin of the "B" spark, as it is called, to the virtual resistance assumed at the instant of discharge by the wire shunting the "B" points, and which is due to the oscillating character of the discharge. Mr. Acheson, however, goes further, and, while recognizing to the full the oscillatory character of the spark and its self inducing properties, claims that the "B" spark is actually a discharge, not from the jar itself, but the self induced and secondary discharge from the wire shunting the "B" points. In support of his theory, Mr. Acheson has brought into play a new factor in the study, that is photography, and the results of his labors in this respect seem to bear out the theory which he has formulated to explain the action observed. As Mr. Acheson remarks, the field here opened has been barely touched, and he himself suggests several directions in which original work may be done.

Wiring Buildings. SOME time ago, we drew attention, on this page, to the practice which seems to be becoming more prevalent, of wiring houses in course of construction without any definite plan or idea in regard to the ultimate system that is to be employed. The folly of such a proceeding, to put it mildly, is well demonstrated in the communication which will be found in another column. In this letter—leaving aside matters of a purely local character—we find the question strongly brought out. In the light of the fact that "systems" do still vary, and will probably continue to vary for some time to come, it is eminently desirable that cases of this kind should not occur, for the general welfare of the entire industry. But if we stop to analyze the cause for such an occurrence, we think it may be truly placed at the door of the architect who gave out the contract. From our own observation, we think it safe to say that very few architects are conversant with methods of wiring buildings, and that their specifications are very general, leaving to the contractor the entire details, as in the instance now cited. The consequence is that the contractor, being allowed all possible liberties, seeks to perform his work according to his own methods, and possibly in the interests of parties with whom he may have affiliations. In the case of gas lighting the architect is guided by the rules laid down for many years, the piping and fixtures being of course similar, practically all the world over; but as this is not yet the case in electric lighting, it would be well, it seems, for architects either to make themselves thoroughly conversant with the requirements of the case, so that they may furnish specifications in detail, or to consult a competent electrical engineer, and delegate that work to him.

ELECTRICAL ENGINEERING AT COLUMBIA COLLEGE.

Probably few announcements have ever been received with more pleasure by the electricians of New York and its vicinity than that of the past week relative to the intention to establish a course in electrical engineering at Columbia College. In fact, the step is one that will win the cordial praise of the profession in all parts of the country, and we may as well confess for ourselves at once that we hail with keen delight this recognition by one of the most prominent and influential American seats of learning of the claims of electricity for support and encouragement.

It is gathered from the statements in the daily press, confirmed by special inquiry on the subject, that the intention of the trustees and faculty of the College is to found a post-graduate course, of one, two or three years, by means of which, under proper instructorship, the young men who entertain the hope of making the practice of electrical engineering their life career can build on the broad foundation of theory the more special and expert acquaintance with the novel problems in electricity that have already ranged it abreast of the older departments of the arts and sciences, and have demanded for their solution the efforts and experience of a new class of engineers.

It may be taken for granted that the authorities of Columbia in making this move, which will redound so much to her credit and glory, have not acted with precipitancy, and yet if the new departure has been in contemplation for any length of time, we must say that the publication of their purpose is peculiarly opportune. Unless we greatly mistake the tendencies and evidences of the day, there is everywhere not only a hearty appreciation of the benefits that applied electricity can confer on modern society, but an intense yearning to know more accurately and precisely the limitations of the field, whether as a science to be investigated or as an art to be utilized. Even in cultured and well-informed circles, one often stands aghast at the wild views expressed by those who, as leaders of public opinion, should know better, while through the mass of the population the ignorance that yet prevails is not far short of utter darkness. It is to our schools and colleges that we must turn for a large part of the educational work that is to change this condition of affairs, and certainly the attempt that Columbia is about to make is of the kind that is most likely to be productive of good results. The preparation on the theoretical side and that which allies electrical engineering to the older standard professions, is such as will naturally fall within the undergraduate course, and then as the student with a ready and ripening mind takes up his post-graduate curriculum he can at once reduce to concrete form all that hitherto lacked definiteness and direction in his work, at the same time being given opportunities to develop into a proficient and expert in the branches that most enlist his enthusiasm and affection.

We have spoken of the need of such men to correct public ideas as to electricity, and to prevent the growth and spread of popular fallacies on the subject. This will, indeed, be a notable part of their mission. Although the art has been greatly helped by the general superstition that electricity can do anything and everything and is exempt from the rule that for power obtained power must be given, its healthful fruitions have frequently been checked by the rank upspringing of countless swindles in the same fertile soil. There is a call for well educated men, alert of brain and hand, whose very training will of itself constitute them advisers of the public, as well as of the State and municipality, in regard to the many new enterprises that are coming to the front as the product of American ingenuity and skill; and in this respect, as before, old Columbia will have done her duty. New York is particularly the home of electrical capital and invention. She has more telephones in her business offices than are to be found in most European kingdoms. She has more electric lighting than any other city in the world. One of her companies—built up by Columbia boys—has more motors running in the downtown districts than are to be found in all England. She is the headquarters of the largest telegraph system in existence. She is the centre of the leading electric railway work, and the territory that is commercially hers teems with electrical industries of every character. In fact, while America is by the generous admission of such critics as Professor Ayrton and Professor Forbes, the land where electricity has attained its greatest development, and is, as the London *Electrical Review* remarks, the country that is leading the way and setting the example,—New York, beyond all rivalry, is the one city where all the new ideas, new systems and new inventions can best be studied as they require to be, molded by the stress of daily use and subject to the incessant improvement that comes with every increase of knowledge.

Under these circumstances, and without in the least forgetting the good work that has already been set on foot in other places to promote the interests of electricity as a technical profession, it is but natural we should be pleased with the action of Columbia College. There is, moreover, another view suggested, and that is the effect that will be had on the profession. The electrical engineer is not yet so well recognized as an essential factor in modern life that he can afford to neglect any legitimate chance that offers to secure the place that belongs to him, and when the officers of Columbia College thus second his claims and determine that with their help his status shall not be lower than is accorded to engineers in any other branch, he may well consider the occasion one for congratulation. In dealing with the questions of the future, the electrical engineer will need all the training and facility he can command, and as the employment of the electric current widens there must go in equal degree a larger ability to meet the heavier tasks. Yet another suggestion arising from the new departure is that, indirectly, it may have its salutary influences on other lines of study in the college. We all know how remarkable in practical work has been the effect of the various electrical services in improving the apparatus that is required for their operation. Telegraphy gave us, if nothing more, new methods of wire manufacture. From telephony have been drawn new ideas in acoustics. Electric lighting has marvelously stimulated steam engineering, and now the electric motor confronts the civil engineer with many a strange difficulty that his highest skill must deal with. It is surely no stretch of analogy to believe that in educational work also, the new study, as exemplified in the Columbia College experiment, may bring about refined adjustments to the changed conditions, and lift the whole system to a loftier platform.

This, however, is anticipating. At present the details of the proposed course have to be elaborated, and much will depend on the lines laid down. Meanwhile it is altogether assuring to know that Prof. Trowbridge, of the School of Mines, takes a warm interest and active initiative in the matter, and will have a controlling voice in the settlement of many points. From the action of the faculty and trustees, so public spirited and farsighted, the brightest auguries as to the execution of the scheme may be formed. If we might venture one word of advice, it would be that the work be begun on a somewhat modest scale, so that it may strike its own deep roots and then follow its own law of growth and unfolding. It is said that the incumbent for the post to be created has already been chosen, and that the name will be given out in due season. For the first few years at least the success of the course will depend on the worthiness of the instructor and on little else, and therefore the greatest care will undoubtedly be exercised in making the selection. Here again we found high hopes on the discretion of the authorities of the College, and are content to await their determination, and to prepare for applauding it.

NEW BOOKS.

BELL HANGER'S HANDBOOK. By F. P. Badt. Chicago: 1889. Electrician Publishing Company. 105 pp., 4 × 6 inches. Price, $1.

Mr. F. B. Badt, whose "Dynamo-Tender's Handbook" appeared some time ago, has in the present work undertaken to impart to novices information as to the best method of what might be called domestic electric wiring, not including electric lighting. The work is a very timely one, as the introduction of electric bells and electric alarms of all kinds, together with gas lighting, electric heat regulating and other devices, is becoming more noticeable every day. The little book begins with a very simple exposé of the principles of voltaic electricity, which is followed up by a chapter describing the various batteries, both open and closed circuit, and other elementary data upon the electric current, Ohm's law, conductors, insulators and the like. The best way of connecting batteries for power, resistance, and other data regarding them, furnishes the contents of the following chapter, and then the subject of electro-magnets, induction coils and electric bells is brought forward. Under the latter head there are descriptions of the single stroke bell, the long-distance call-bell system, buzzer, push button, etc. The various annunciators, electric alarms, gas-light apparatus, electric heat regulating apparatus which are in use, their method of erection and the running of the wires are entered into with great detail, so that an intelligent workman may easily construct any of these circuits. The little volume ends with a description of the various test instruments with which faults can be localized in house work.

An Electrical "Scrap-Box."

BY E. S. GRAVER.

Noticing the descriptions of different methods of keeping scraps, and noticing, further, that none of them are like my plan, I herewith append a description of my idea.

It consists of a box which is made in the shape and of the general appearance of a book, about the size of an unabridged dictionary, but not quite so thick. In this box, which is made of thin wood, there are twenty-six books of five leaves each. Each book is assigned to one letter of the alphabet and each leaf of each book to a vowel. In this way there are one hundred and thirty subdivisions in the book [box]. All that is necessary is to cut out your scrap, hunt for the first letter in its title, and then for the first vowel in the first word of the title, and then simply place the scrap between the proper leaves, when the whole thing is nicely filed and indexed and can at any time be taken out.

Suppose the subject to be "Locomotive Driving Wheels." We place the scrap in book L on page O (the first vowel in locomotive). We can also place a slip of paper in book D, subdivision I, marked, "See Locomotive Driving Wheels." In the same way we can place a slip for the word "wheels."

This plan, I think, is the best that can be used. It has all the advantages of the card index as well as all the advantages of a scrap book. Owing to its shape and "get up" it can be placed among other large books, and no one would suppose that it was not a book.

It is superior to a scrap book because there is no need of keeping paste always at hand, and the cuttings are not damaged and can be handled without the clumsy scrap book.

It is superior to a card index, for the reason that while you are hunting the title on the cards you can find the article itself by this plan and thus save one operation.

Electrical Clippings or Scraps.

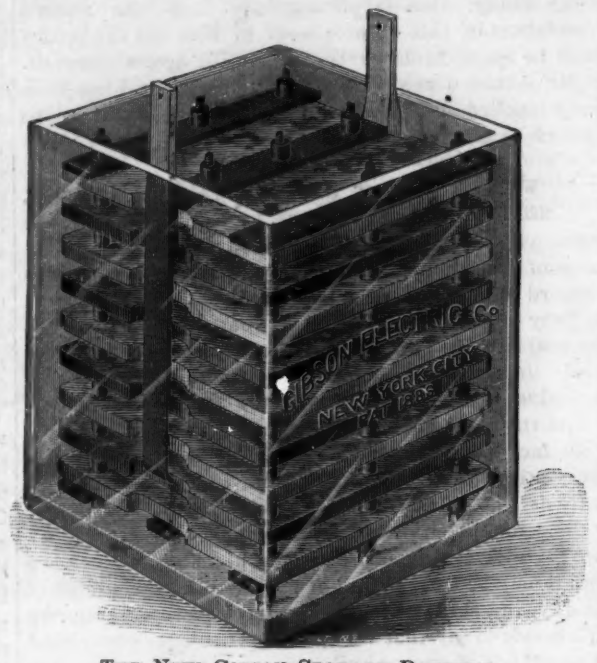
BY GEORGE CUTTER.

The various articles about an electrical scrap book have interested me very much, as I consider mine about the most valuable book in a fairly large collection. As the system I have adopted is different from any outlined thus far, I make bold to mention it.

The great difficulty with scrap books in our department of study arises from the rapid growth of the business, so that an arrangement suitable for to-day may not be at all suitable for two or three years hence. Therefore, if a man wishes his scrap-book arranged conveniently, he will find it necessary to change the clippings from time to time, and even then it would be simply impossible to have the book sufficiently classified to be of the best service.

The method which I adopted about three years ago was to have uniform sheets of ordinary brown paper to which my clippings were pasted; then have a classified file for these sheets. In this way I am enabled to throw all my scraps as collected into a drawer which I reserve for the purpose in my writing desk, and then when the "notion" strikes me, I paste them on to sheets of brown paper, not having any trouble about the classification at the time of pasting. Then when the classification notion strikes me, I file away these sheets under the various headings, and if, as has already happened, I change my notion about this classification, it is a very short job to rearrange all my clippings. If I happen to be studying about alternating current dynamos I find all the various clippings pertain ing to them in one package, and I can take them out and study them as I choose. No index or catalogue is required.

I adopt this same method for my notes and sketches. I carry small sheets of paper of uniform size in my note-book, and whenever I think of anything that interests me I make a plain heading to the sheet, and make the note, diagram, or sketch, whatever it happens to be. Then when I have time I file these away according to classification. This I find to be far preferable to a miscellaneous note-book. My friend Curtiss, of the Thomson-Houston Company, uses the same method of filing away



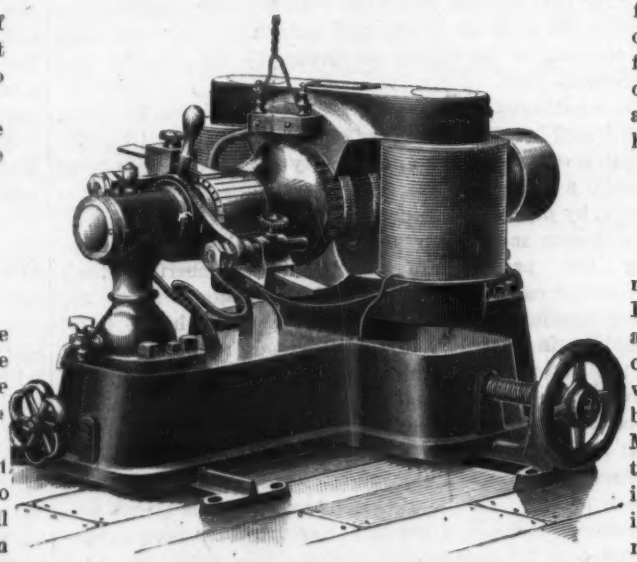
THE NEW GIBSON STORAGE BATTERY.

his scraps, and speaks very highly of it indeed, and I find it very flexible, and the least trouble of all the systems I have tried.

The Denison Motor and Dynamo.

The accompanying engraving shows the type of dynamos and motors recently brought out by Mr. J. F. Denison, manufacturing electrician, New Haven, Conn. The general construction of these machines does not differ widely from those lines which practical use has shown to be the best, but the motors have several points worthy of consideration. The mechanical construction is of the best, and all machines are provided with self-oiling boxes. The illustration shows a 1½ h. p. constant potential motor, wound for 110 volts. These machines are built with a very low resistance in the armature, and are shunt wound; the regulation is therefore very close. The constant current motors are provided with a delicate governor, making them, it is claimed, equal in all respects to the constant potential machines.

All the motors are self-contained, the rheostat being in the base of the machine and manipulated by a hand wheel. This arrangement is known as "Denison's interlocking starting attachment," and effectually prevents any mistake in operating the motors. The attachment is so arranged that the motor cannot have the current thrown on unless the resistance is in the proper position; and in case of accidental breaking of the circuit, there is provided an automatic lock that makes it impossible to turn the current on, until the resistance is again placed in normal condition. The absence of rheostats and other attachments external to the machine, and usually placed on the wall, saves the expense of sending out a special attendant to set up the machine. As there are but two binding posts, it is impossible to make a mistake in wiring up a motor. These motors are wound for all commercial circuits, and Mr. Denison devotes particular attention to building machines for special work.



THE DENISON MOTOR AND DYNAMO.

The New Gibson Storage Battery.

We illustrate on this page the new form of the storage battery which has been brought out by the Gibson Electric Company, of this city. The striking feature of this cell is the arrangement adopted for the plates, which, instead of being vertical, as usually the case, are here ranged horizontally one over the other. The plates, as will be seen, are strung on bolts which pass through from top to bottom, and "distance pieces" between the plates keep the latter apart and prevent short circuiting. It will also be noticed that the plates are placed somewhat more widely apart than it usually the case, by which means local action between contiguous plates during the idleness of the cell is prevented. These cells are now made in sizes varying in capacity from 75 to 175 ampère hours, the former weighing, complete, 29 lbs., and the latter 55 lbs.

Technical Notes from Cornell.

BY G. H. SHEPARDSON.

The readers of THE ELECTRICAL WORLD may be interested to learn that Mr. J. W. Granger, instructor in the Sibley College blacksmith shop, has succeeded in *welding copper at the forge*, and has made a copper chain of $\frac{3}{16}$ inch copper wire. This feat, I believe, has never been accomplished before.

Several original investigations are being carried on in the laboratories. By making small changes in a Ball unipolar series dynamo, I have succeeded in getting a well regulated *constant potential* from it. Investigations by Messrs. Nakano and Merritt show that of the total energy radiated by an incandescent lamp at normal candle power about 6 per cent. is light, while with an arc lamp only 3 to 4 per cent. is light; proving that for a given actual amount of light radiated the *incandescent lamp is more efficient than the arc.* This is contrary to common belief.

Applications of Motors to Traveling Cranes.

The advantages of traveling cranes in erecting shops of establishments manufacturing heavy machinery are more widely admitted each year. And while American shops, says *Engineering*, have neglected these important tools to an extent hardly to be explained by the habits of a nation so prone to do or see some new thing, yet their use within a very few years has been widely extended in large shops in the United States. There are two well-known methods of transmision of power to a traveling crane, one by means of a square shaft, and the other by means of a rapidly traveling rope. But it appears that there are are many places where other methods of transmission of power could be readily used, but which involve an independent motor on the crane. There would be difficulties in the way of conducting steam through a flexible tube traveling over so long a distance, and water operating the motor, while fairly practicable, would yet be beset by many difficulties. The problem offers a good deal of promise to those who would use compressed air for operating a motor under such circumstances, and it would be in the way of a still more practicable settlement if electric motors were used for such purposes. The distance would be a very short one for the transmission of electricity; much shorter in fact in relation to the difficulties which beset other forms of energy, while the amount of power required is so small as to be readily within the limits which electric motors have already proved to be practicable.

Electricity and Artesian Wells.

The discharge of water from artesian wells has for many years been employed as a motive power in France. In the city of Tours there is an artesian well which drives a hydraulic wheel 7 m. in diameter, and works the machinery of a silk factory. At Grenelle the heat of the water issuing from a deep well is utilized in warming buildings. A project is now before a commission of the Municipal Council of Paris, having for its aim the utilization of the power obtainable from the new artesian well in the Place Hébert, at La Chapelle. There are now three important artesian wells in the Paris basin, that of Grenelle being the oldest, and that at Passy the most productive. The new La Chapelle well is particularly adapted for the experiment of producing motive power. Besides these there are a number of private artesian wells in Paris belonging to manufacturers. The La Chapelle well was finished in March last, having been begun 24 years ago. It reaches a depth of 720 m., and the water, left to itself, rises to a height of 35 m. above the mouth. It furnishes 6,000 c. m. of water in 24 hours. The proposal is to utilize the power furnished by the well in generating and distributing electricity for lighting and motive purposes. One object mentioned is the lighting of the park of the Buttes Chaumont, which is situated near the well. Before now electricity has been generated in this manner. It will be remembered that the Ponce de Leon Hotel at St. Augustine, Fla., has a powerful artesian well which drives a turbine wheel and dynamo, thus generating the current necessary to light part of the building and its grounds. At Yankton, Dak., there is also a flowing well which drives the

dynamos of an electric light company. The well is 600 feet deep, and the water on issuing from it is conducted to a reservoir placed 30 feet above the turbine which actuates the dynamos, as described in our columns some time ago.

The New Uptown Edison Stations, New York.

The Edison Electric Illuminating Company, of New York, after seeing the satisfactory financial results secured from the Pearl street station, and having become firmly established in the production and sale of electric light, recognized the importance of proceeding to supply other sections of New York city with the Edison light. In order to secure to themselves the best construction and the greatest improvements in machinery and apparatus of this system throughout, they appointed a Construction Committee. This committee was composed of Mr. E. H. Johnson, President of the Edison Electric Light Company; Mr. C. H. Coster, Director of the Edison Electric Light Company and of the Edison Electric Illuminating Company; Mr. John I. Beggs, Vice-President and General Manager of the Edison Electric Illuminating Company of New York; C. E. Chinnock, the former General Superintendent of the Edison Electric Illuminating Company of New York. Mr. J. H. Vail, the General Superintendent of the Edison Electric Light Company, was appointed Chief Engineer of the committee. Mr. Chas. E. Emory, M. E., was retained as Consulting Engineer, and Mr. Albert Buchman as the Architect.

After making a careful investigation of the lighting in New York city, it was decided to lay out such a system of generating stations and conductors for distribution of current as would supply the territory bounded by Seventeenth and Fifty-ninth streets and Third and Eighth avenues.

The light will be furnished to the principal hotels, theatres, restaurants, dry goods and fancy stores and commercial houses in the district, together with a large proportion of the residences in the cross town streets. The light will be sold to the consumers through the Edison meter. Electric motive power will also be supplied in either large or small quantities throughout the district to such parties as desire it.

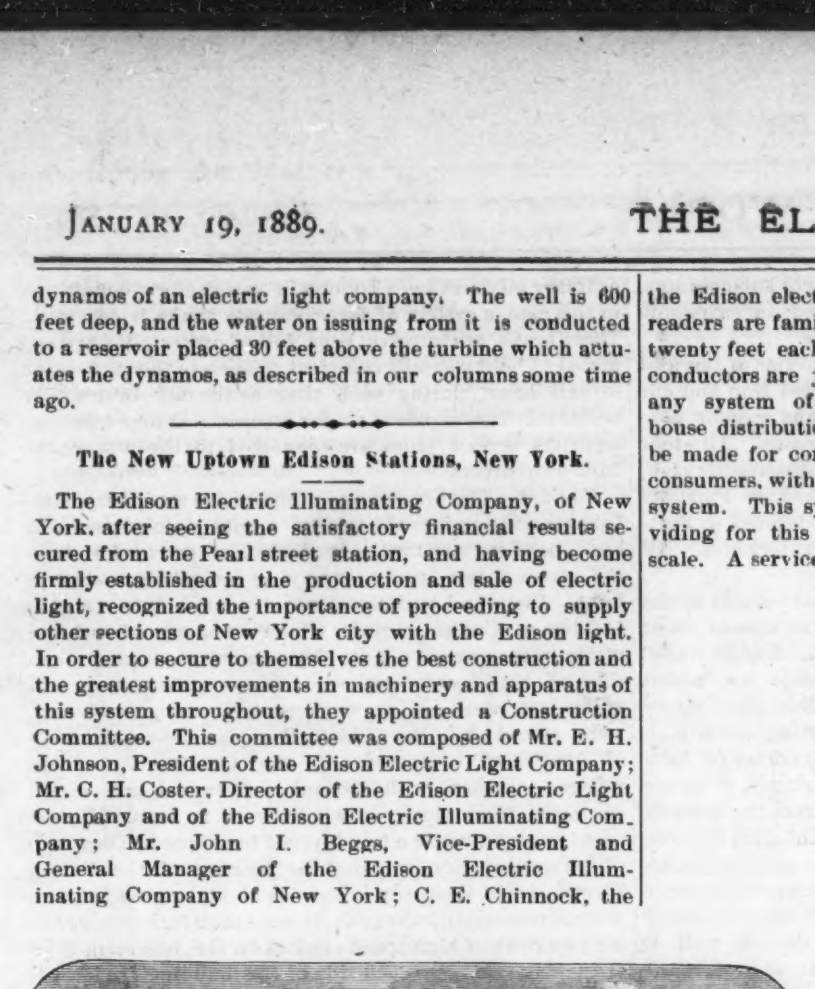
The distribution of the electric current throughout this large area is accomplished by the Edison three-wire system. The underground conductors consist of the Edison electric tubing, with the details of which our readers are familiar. The tubes are made in lengths of twenty feet each, are joined by connecting boxes. The conductors are joined by flexible copper connectors. In any system of underground conductors for house to house distribution of the electric current, provision must be made for conveniently making service connections to consumers, without interfering with the working of the system. This system of conductors is the only one providing for this important matter on a comprehensive scale. A service connection can at any time be made by removing the straight connecting box and substituting therefor the tee connecting box.

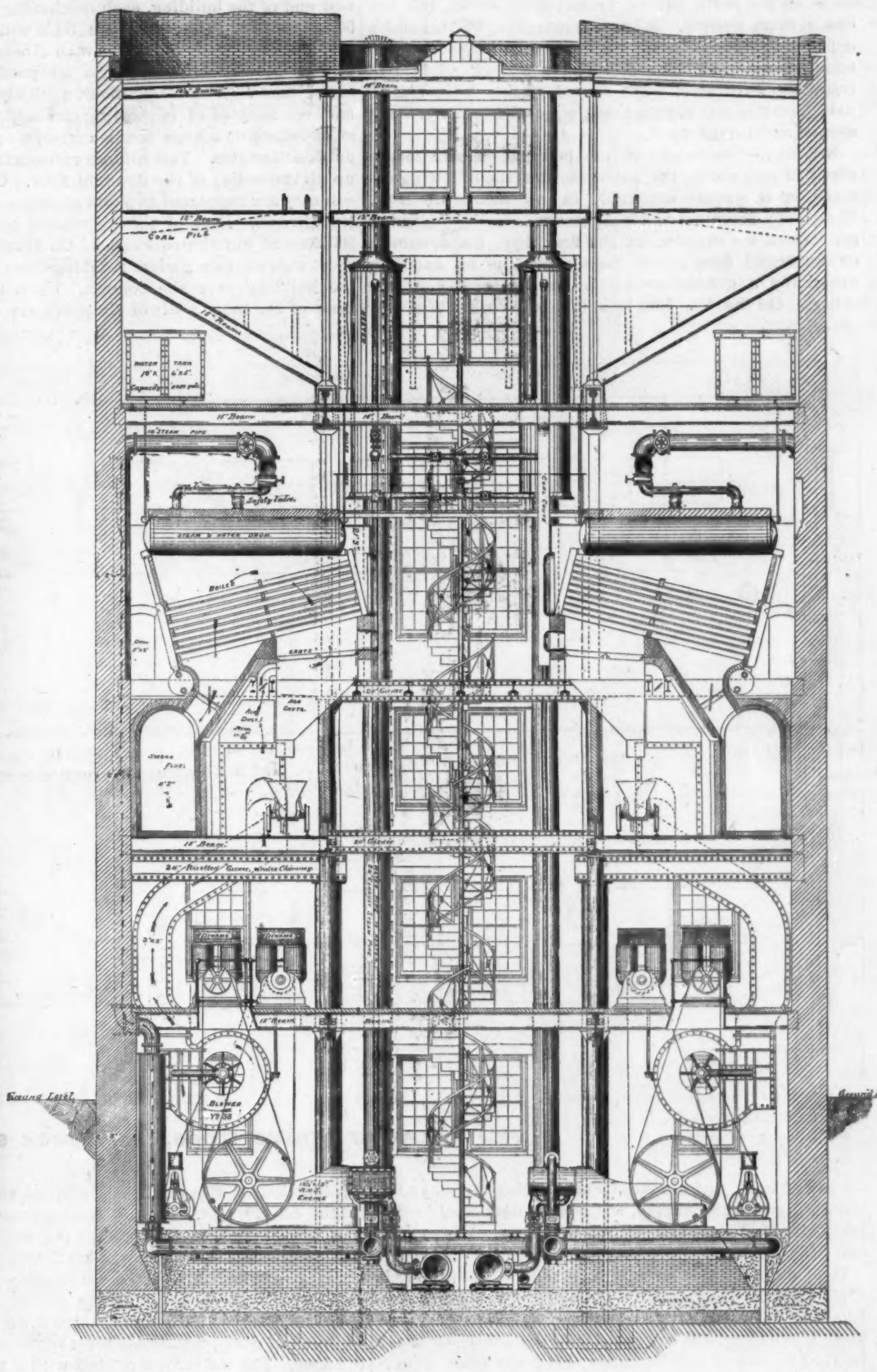
The necessary electrical connections being made the service is continued to the building. The mains are laid on both sides of the street in trenches about two feet deep and about the same distance from the curb line. The feeders extend from the station in a continuous line to the proper points for perfect distribution. There are junction boxes located at the street intersections. At these the feeders end, and from these the mains depart in all directions. The entire system is ingeniously interlocked by safety fuses, protecting every section of main as well as each feeder. The conductors for the above-mentioned district have a current carrying capacity sufficient to permit connecting 200,000 16 c. p. lamps. We may here mention that there is already in use in the cities of New York, Boston, Philadelphia, Detroit, Rochester, Columbus and Chicago upwards of 180 miles of these tubes.

In large cities the conditions governing the construction of stations for the generation of the electric current are of a peculiarly difficult character These conditions compel the construction of stations of unprecedented capacity on ground plots of comparatively small area, and have necessitated the designing of buildings entirely different from anything heretofore attempted in the annals of electrical engineering.

The Edison system has made enormous strides since the starting of the Pearl street station, both in its economical production and in the distribution of the current and arrangement of the steam and electrical plants in the stations. The two new buildings in this city are absolutely fireproof and unusually massive in their construction, having an interior iron framework of immense strength. The arrangement of the plant is a complete reversal of the designs heretofore followed, not only in other stations but in steam plants generally. In a station of this character there must be provided a large maximum horse-power so subdivided in units of moderate capacity as will secure the highest economy during the daily hours of light load, and whose units will be so arranged as to be ready for instantaneous connection in the circuit in case of unexpected demands for light in large quantities. The sum total of these units must provide the maximum quantity of current required in the district either on gradual or sudden changes. Provision must be made for the storage of considerable amounts of extra fuel as a reserve supply in case of strikes or difficulties of transportation, also for the economical handling of the fuel and of its refuse after it has served its purpose of generating steam. Further provision must be made for unfailing water supply, as well as a reserve in the event of the city supply being suddenly cut off either for repairs or by extra demands for fire purposes.

In order to fulfill all these numerous requirements which have made themselves evident from an extensive experience in central station construction, it was decided to adopt with necessary modifications the original and





FIGS. 1 AND 2.—THE NEW EDISON STATION, WEST 26TH STREET, NEW YORK CITY.

comprehensive designs prepared by the Chief Engineer. The arrangement of machinery and apparatus secures the economical concentration and classification of all labor employed in the operation of this class of station. It secures the placing of the necessary number of engineers and oilers in the engine room, the requisite electricians and dynamo tenders in the dynamo room, the firemen in the boiler room, with two or more general workmen for the hoisting and delivery of coal and the removal of ashes and other miscellaneous work throughout the building. It will thus be seen that but few men are needed to handle a station of this very large capacity.

Property and Excavation.—For the first station, the lot is on the north side of Twenty-sixth street, 100 feet east of Sixth avenue. It has a frontage of 56 feet and a depth of 98 feet 9 inches. The excavation for the foundations was made out of solid rock to a depth of 14 feet below the curb level. The second station is in Thirty-ninth street nearly opposite the Casino, and between Sixth avenue and Broadway.

Building.—The height of the building in each case is about 90 feet above the sidewalk, and the following description is strictly applicable in all details to both. There are a basement and four stories. In the basement are located the engines; on the first floor the dynamos; on the second floor smoke flues, apparatus for handling ashes, and a general workshop; on the third floor the boilers. On the top floor is a loft or "pocket" for the storage of coal, just beneath its sides being the tanks for the storage of water supply, the commodious meter room being also located at the front on this floor. Figs. 1, 2, 3 and 4.

The buildings are fireproof throughout. The thickness of the walls in the basement is 3 feet; in the first and second floors, 2 feet 8 inches; third floor, 2 feet 4 inches, and fourth floor, 2 feet. As will be seen from the illustration, the front elevations of both buildings, which are alike, is characteristic of the purpose to which they are applied. The principal features that have been kept in mind by the Engineer and Architect are the most substantial construction combined with superior facilities, for operating the steam and electrical plant, ample ventilation and good light. The foundation courses and trimmings are of rough hewn granite where deemed necessary. All of these courses are laid through the entire thickness of the wall. The main front of the building is laid in pressed Collobaugh brick relieved by pilasters on each side. Large exterior openings are provided for the engine-room, dynamo-room and boiler-room, furnished in each case with handsome wrought iron guard gates. Access from the street is provided at each side of the front by door ways 6 feet in width. As we enter the buildings we find a wrought iron stairway on each side leading down into the engine-room, and up into the dynamo-room. These stairways are continued on one side of the building leading up to the different floors as far as the roof. In the rear of the building there is a spiral wrought iron stairway leading from the basement to the top floor.

The Iron Work.—There are two lines of main girders running fore and aft of the building on each floor. These are supported on two rows of very substantial iron columns, which gradually diminish in size with each increase in elevation from the ground. It may here be mentioned that there are also on the second floor eight sub-columns, starting on large girders of that story, used as extra supports for the beams under the boiler walls.

Arches.—The arches between the floor beams of the first and second floors are formed of corrugated iron and one thickness of tile filled in with best stone and cement concrete level with the top surfaces of the beams. All other arches, including those of the roof, are Guastavino tile arch.

Finish of Floors.—Each floor is finished in Portland cement. The roof is laid in large tiles bedded in Portland cement and concrete over one foot in thickness. All flashings are of copper throughout.

Smoke-Stacks.—There are two large smoke-stacks at the rear end of the building, each one having an area of about 50 square feet. The stacks are built with double walls; the interior wall is lined with fire-brick for about 40 feet up. In order to gain all possible floor space in the basement and first floor, a highly ingenious plan has been adopted of supporting the inside corner of each smoke-stack on a huge double cast-iron column, 20 inches outside diameter. This column extends from the bedrock up to the ceiling of the dynamo floor. On each of these columns are supported two sets of extra heavy wrought-iron girders. Each of these girders is estimated to carry 300 tons of distributed weight. On these rest two sets of short combination girders reaching from the rear wall of the building over the column. Upon these girders the bases of the inner walls of the stack are started, and the construction of the stack is continued to the necessary height of 160 feet. By this arrangement a space of at least 120 square feet is gained on the engine room floor, and a similar space on the dynamo floor.

Finish of Engine and Dynamo Rooms.—The basement of the buildings, occupied as the engine room, and the first floor occupied as the dynamo room, are finished with a wainscot of dark purple slate for a space of 6 feet above the floor. The wainscot is capped with a nosing of slate, and above this is a band course, about 2 feet wide, of ivory-colored English enameled brick. Another band course of buff brick reaches to within one foot of the ceiling. The cornice is built of Philadelphia brick, finishing up to the ceiling. The arches between the beams are, as before noted, of corrugated iron. These are tastefully painted in light colors.

Toilet Conveniences.—Each floor also is suitably fitted up with toilet conveniencies for the employés and with proper closets for clothes, towels, etc.

Pump Room, Coal Vaults and Feeder Entrance.—A large vault, conveniently divided off, has been excavated under the sidewalk. The east and west compartments of the vault are used for the entrance of the feeders of the underground system. Two coal vaults are also included, each having a capacity of about 8 tons, with the floor at such an angle that the coal is automatically delivered into the car as it stands at the bottom of the elevator shaft. The central compartment is used as a pump-room.

Pumps and Reliable Water Supply.—Two large Davidson pumps and one smaller one of the same type regulate and control the water supply for feeding the boilers. These are located in the vault under the sidewalk as before mentioned. Another extremely important matter in a station of this character is that ample provision should be made against the occurrence of any intermission of the ordinary city service. To obtain satisfactory conditions in this case, a system of large storage tanks is provided. These tanks are always kept full of water, and are estimated to hold a supply sufficient to operate the station for several hours, during such time as the city service may be cut off from accident or for repairs. As an additional security, service pipes are connected to the city mains from two streets.

Engines.—The Construction Committee made very careful examination into the relative merits of slow speed and high speed engines for the production of power for driving dynamos in a station supplying incandescent electric light. Plans and estimates were secured from reliable builders of Corliss engines, whose economy of fuel and water was guaranteed to be somewhat higher than that of high-speed engines. These plans and estimates, as well as a very careful analysis thereof, were placed by the Chief Engineer before a body of gentlemen composed of the Construction Committee, together with several well-known and expert engineers, the majority of whom were in favor of slow speed engines, while a few favored high speed. The result of the examination was that the position of the Edison Electric Light Company in the use of high speed engines was unanimously indorsed. It was, therefore, decided to set two rows of high speed engines on the basement floor of each station. On each side of the building are located seven engines, making a total of 2,800 h. p. when working under normal conditions. These engines are of the Armington & Sims type. They are built in accordance with special specifications furnished by the Chief Engineer, and are extra heavy, and very substantial in all the details of their construction. The cylinder of each engine is 18¼ inches diameter by 18 inches stroke of piston, and the speed is 200 revolutions per minute. There are two driving wheels, each of which is 86 inches in diameter by 16 inches face. The weight of each wheel is not less than 4,500 pounds. Each engine is provided with an Armington & Sims automatic regulator, and develops 200 h. p., cut off at ¼ stroke, under pressure of 90 pounds, at the throttle. Each engine is fitted with a large automatic sight feed cylinder oiler, which for extra security is reinforced by an oil pump that can be used in case of emergency. The guides and all other working parts are provided with drop sight-feed oilers of ample capacity. A system of oil channels has been carefully laid out, which drains all the oil from each engine into a channel from which it is led off to be filtered for future service. Each engine is mounted on a cast-iron foundation box filled in with concrete.

Engine Foundations.—Some details of construction of the engine foundations may be of interest. On each side of the building are rows of seven of the engines above described. On a bed of concrete is built a substantial brick foundation for each individual engine. After the individual foundations had been constructed, all the intervening spaces between the foundations were filled in with the best quality of concrete, composed of cracked stone and Portland cement mortar thoroughly rammed down. The necessary channels are provided for the reception of steam and exhaust pipes which are laid under the floor. By this arrangement we have on each side of the building seven engines standing on a massive base of solid

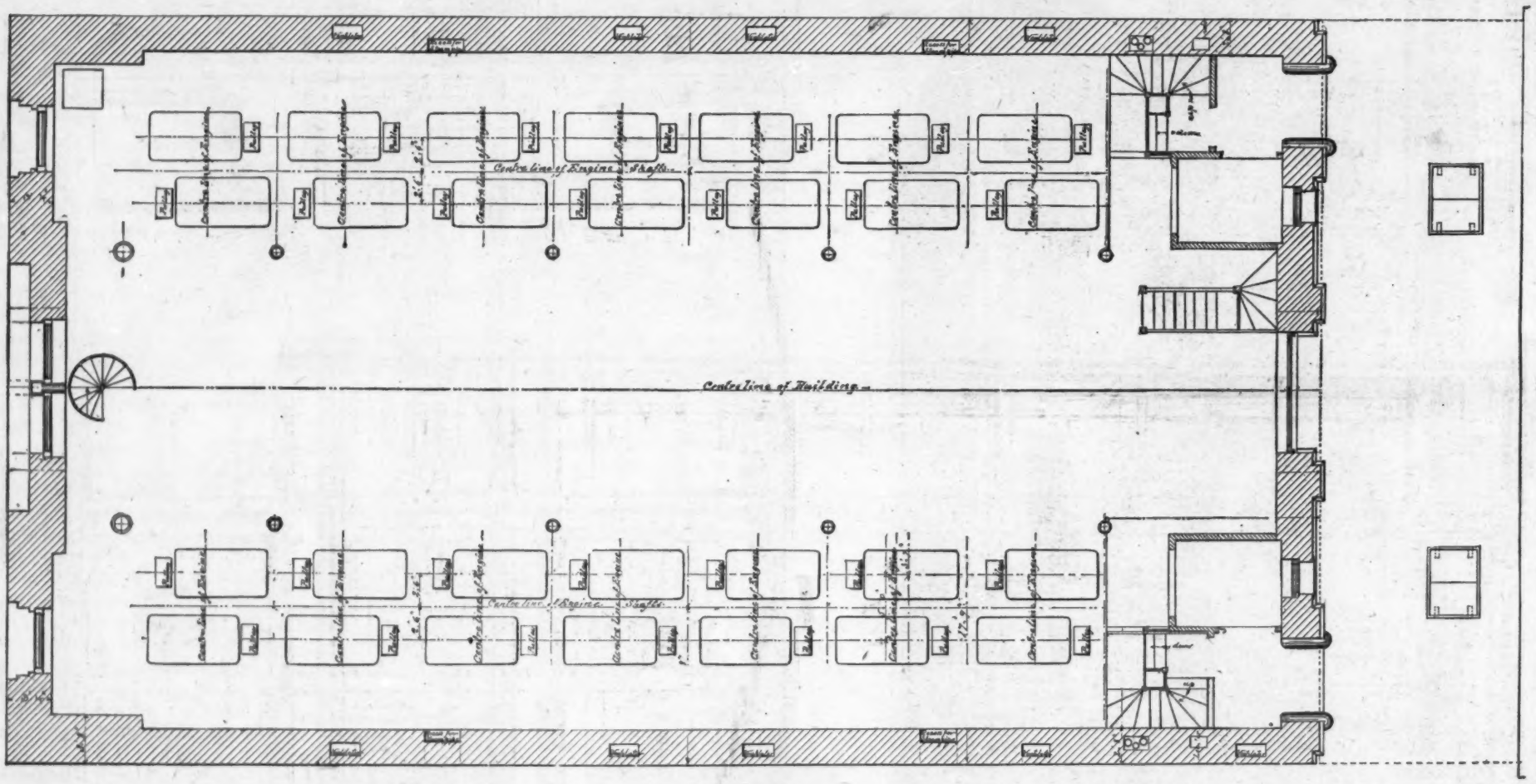


FIG. 3.—PLAN OF DYNAMO FLOOR, NEW EDISON STATIONS, NEW YORK CITY.

mason work. This massive foundation is built absolutely independent of the foundation walls of the building, and of the iron columns supporting the interior structure. On this floor at the rear are located two large pressure blowers for increasing draught on boilers.

Dynamos.—On the first floor of the building are located the dynamos. These are 28 in number, of an entirely new type and construction, and are of larger capacity than anything heretofore built, with the exception of the celebrated "steam dynamo," which was constructed early in the development of the Edison business. Each of hese dynamos has a capacity of 600 ampères and an initial E. M. F. of 140 volts. They weigh about 15,000 lbs. each. The speed of the armature is 650 revolutions per minute.

Work Shop, Smoke Flue, etc.—The second floor of the building has a central space fitted up as a general work shop and repair room.

On each side of this central space next to the wall are located the large horizontal smoke flues leading from the boilers, extending along each side of the building all the way to the rear and connecting with the smoke stacks. Between the smoke flue and the partition dividing off the workshop are located the ash pits, also the ash cars and track for handling ashes.

Handling Ashes.—The ash-pit under each boiler is constructed in the form of a large hopper of boiler iron plates. It is closed below by a convenient form of gate. This pit holds all the refuse accumulating from the boiler above this floor between the batteries of boilers, and abundant facilities are provided for light and ventilation. The feed-water heaters are of the Baragwanath pattern, and have been constructed after special designs furnished by the Chief Engineer.

Coal Storage and Hoist.—A highly essential point in buildings of this character is ample facility for the handling of coal, its storage, as well as its economical delivery in front of the boilers, and the disposal of the ashes with the least possible labor without unnecessary dust or dirt. In the coal loft are facilities for a storage of about 1,000 tons of coal, and for its automatic delivery thence through vertical chutes to the front of the boilers, ready to be handled by the firemen. On looking at the floor plan of the

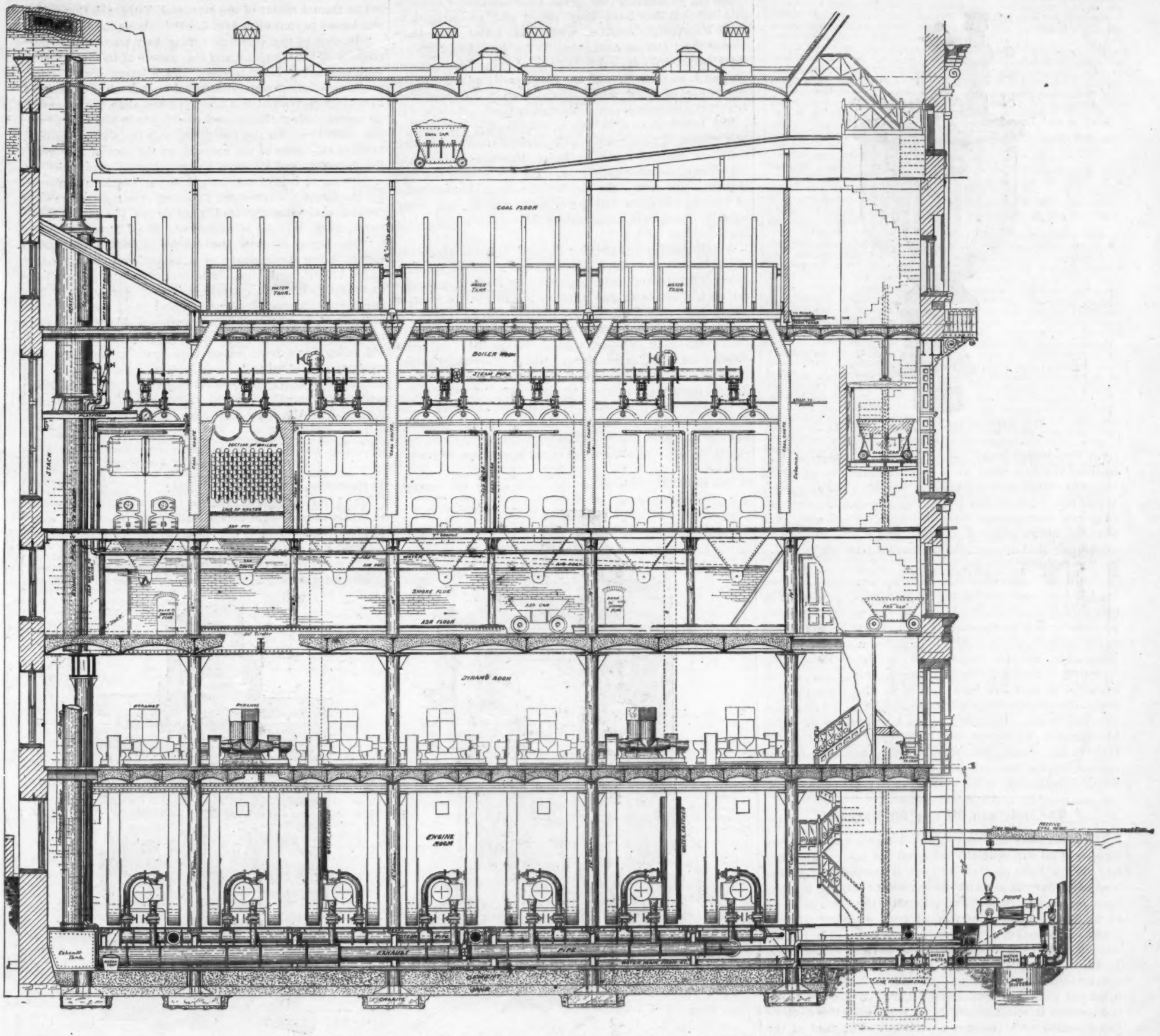


FIG. 4.—SECTIONAL VIEW OF THE NEW EDISON STATIONS, NEW YORK CITY.

Two dynamos are driven by each engine. Fourteen of these dynamos are, as already intimated, to be located in a double row on each side of the building.

Electrical Apparatus.—The central space of the dynamo room is equipped with the necessary electrical appliances in the way of automatic feeder equalizers, individual ampère meters for each dynamo, main ampère meters for different divisions of the underground system, volt meters for indicating the electrical pressure throughout the different portions of the district, and such other minor appliances as are required for the proper operation and control of the system. These are all conveniently arranged for rapid manipulation and economy in time and labor, and give absolute control of the electrical pressure and quantity of current. All the electrical apparatus excepting pressure indicators, was manufactured by Bergmann & Co. and is the finest outfit in material and workmanship ever placed in an electric light station.

during 24 hours service. By reference to the plans of the second floor, it will be noticed that there is a track running on each side of the building directly under the ash pits and parallel with the horizontal smoke flue. Each of these tracks is provided with suitable ash cars, equipped with automatic dumping devices. These cars on being filled from the pits are shoved to their respective front corners of the buildings, over a large pocket, built in the mason work, and here the ashes are dumped. This pocket has a hopper at the bottom, with suitable closing device, which is opened when the ash cart below is to receive the load, and it is calculated that under the maximum station service all of the ashes produced in each 24 hours is easily removed inside of three hours.

Boilers.—The third or boiler floor of the building has on each side a large battery of Babcock & Wilcox water tube boilers, each battery having a capacity of 1,400 h. p. There is a large and convenient fire room the entire length of

buildings, it will be seen that these important matters have been duly provided for. There are two large elevator shafts leading from the basement up to the roof. Each one of these is supplied with an elevator platform constructed entirely of wrought iron. These are geared up as balanced elevators, winding and unwinding on the same drum and operated by a double cylinder engine of ample capacity located in the basement. For each of the platforms a wrought-iron coal car is furnished, capable of holding 1½ tons of coal. Supported about midway between the floor and ceiling of the coal loft are three car tracks, to the level of which the coal is hoisted in the car. When the load of coal arrives at the top of the elevator shaft, the car is shoved off on a weighing platform. The car is dumped by automatic apparatus, at any point desired, and the car returned to the elevator platform. In the meantime the other elevator with its empty car has descended and is receiving its load, and thus the work is

continued. The elevators were constructed by Messrs. Crane Brothers.

Station Capacity.—With the station capacity as described, there can be produced at any one time, at each station, a supply of current for maintaining at proper incandescence 35,000 16 c. p. lamps for any consecutive numbers of hours that may be required. This will supply at least 50,000 lamps connected to the mains of the underground system. The combined capacity of the three stations, a third and larger being proposed and under course of construction, will be 160,000 16 c. p. lamps at one time, which will permit of at least 250,000 lamps connected to the mains of the entire district.

Margin in Capacity —An important feature of all Edison central stations is the margin above their rated capac-

THE LONERGAN DYNAMO OIL CUP.

ity. That is seen in the present instance. Although these stations are each rated at a nominal capacity of 35,000 lamps as stated above, great care has been taken to have ample reserve in all the generating apparatus. Any one of these stations can be called upon for an excess of 25 per cent. above its rated capacity, and would respond so generously that not a single part would be subjected to undue straining.

It will have been seen that a stupendous piece of work has been carried out in the construction of these two magnificent stations, which are now to be supplemented by a third, further up town again. The superintendence of the construction has largely devolved upon Mr. John I. Beggs, the general manager of the local Edison Illuminating Company, who has been indefatigable in his supervision, and has been fertile in the suggestion of means for economizing space and money as the construction progressed. He now has the honor of having under his direction and charge the finest local electric lighting plant in the world, including, at once, the oldest and the newest Edison stations, and representing practically the whole development of the system.

The Lonergan Oil Cup for Dynamos.

The accompanying cut represents a new and improved sight-feed oil cup specially adapted for use on dynamos and electric light plants. The cup is composed of a clear lead glass, very heavy and strong, with highly finished brass mountings connecting internally the brass parts, so as to form a tight joint against cork washers with the glass. This makes a perfectly tight receptacle for oil, and one easy to disconnect for the purpose of cleaning. To fill it, it is only necessary to move the slide *A* (which covers the filling hole) to one side. When the cup is filled the slide is moved around till it covers the filling hole, where it will tighten, as it screws on the neck of cap *B*, acting as a check nut on itself. The feed of the cup is regulated by a set screw *M* which passes through the rim of crank *H* and rests on the nipple *N*. When the cup is feeding, and with the action of set screw *M*, the exact feed required can be secured, and when once secured need not be altered, as when no feed is required it is only necessary to lift crank *H* and turn it slightly to one side, so that the screw *M* may descend from its seat on nipple *N*, thereby allowing the feed to be entirely shut off. When the feed is again required it is only necessary to raise screw *M* on the nipple *N*, as before, when the exact feed will be resumed. Thus, changing from feed to complete shut-off prevents the feed outlet from clogging without changing the original set of the feed. By lifting the crank *H* vertically, a stream of oil from the cup can be made to flow to the bearing, and all this without changing the set feed of the cup when placed on feed nipple *N* again. This cup has been adopted by some of the largest electric lighting companies in the United States and gives general satisfaction. It is manufactured by J. E. Lonergan & Co., of Philadelphia, who are the patentees.

The Racine Oil Burning Steam Outfit.

In these days, when the question of the use of kerosene or crude oil, as a fuel, is attracting so much attention, and when it has assumed such proportions that a pipe line to carry oil from Ohio to Chicago has been constructed at a cost of nearly a million and a quarter of dollars; when many of the largest rolling mills, glass works, paper mills, brick yards, etc., etc., are using crude oil at a large saving of fuel and of labor for handling, any new device or adaptation pertaining to such use will be of interest to our readers.

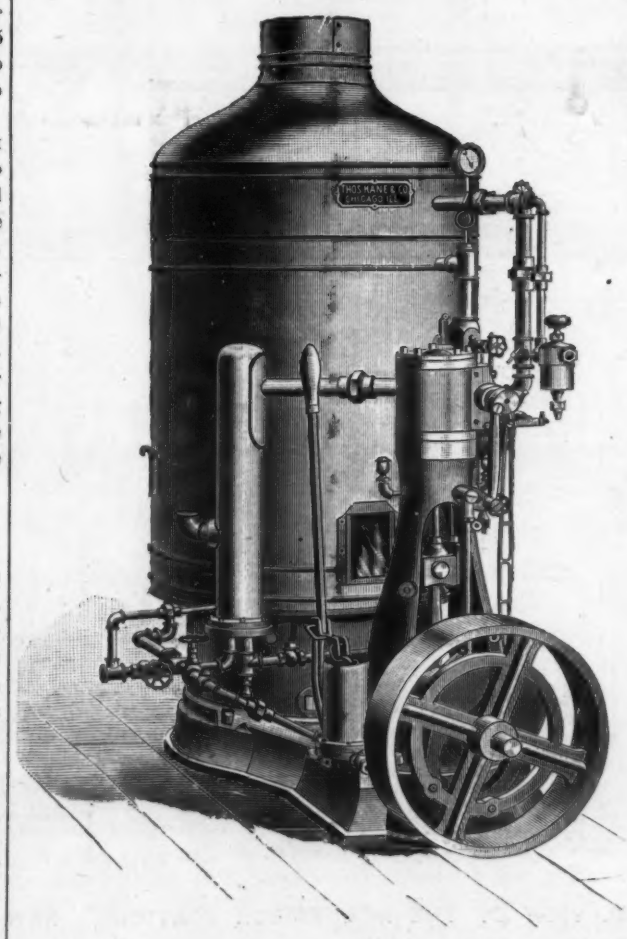
The manufacturers of the outfit mentioned in this article have for some time built it for pleasure yachts, engines and boilers, with a burner adapted to kerosene or crude oil, as desired. So great has been their success in this line that they have been urged and encouraged to make a stationary outfit as well. This latter they have named the "Racine Automatic." As just stated above, these outfits are adapted to the use of either kerosene or crude oil, as desired, and are also equally adapted to the use of coal or wood when mounted on a different base, which the makers provide when so ordered.

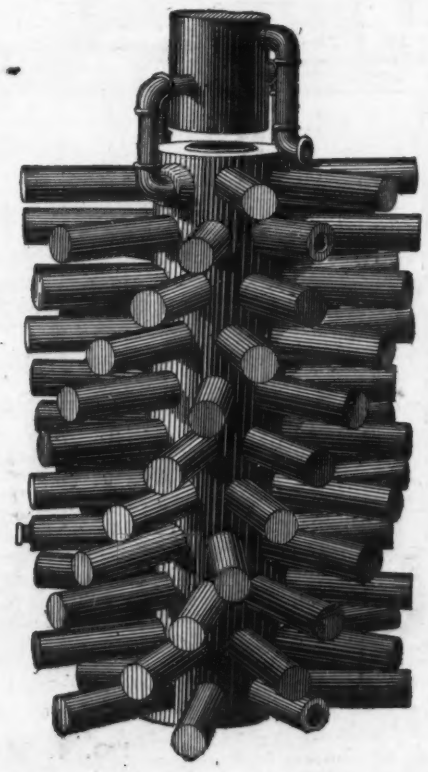
The boiler shown in the accompanying cut consists of a system of small tubes with welded ends, radiating from an upright central column, through the centre of which runs another large tube. The fire passing through this tube and around the smaller ones gives the maximum of heating surface to any given space, and as only small tubes are used in its construction the maximum of safety is attained as well.

A valuable feature of the "Racine" boiler as applied to oil is the furnace, which is fitted with a special arrangement of combustion plates, which receives the atomized oil at a white heat, and converts it into gas. A plunger pump and an exhaust steam heater, which supplies the boiler with water at nearly boiling point, is supplied with each outfit. In addition each boiler is fitted up with steam gauge, pop valve, steam whistle, glass water gauge, blow-off cock, and a float that regulates the supply pump automatically.

The atomizers are made varying in size, and from a one horse-power up to a boiler of 125 horse-power capacity, but one burner is needed. The atomizer is simple in construction, not liable to get out of order, and can be readily cleaned.

The manufac urers send out with every oil burning





FIGS. 1 AND 2.—THE RACINE OIL ENGINE.

boiler a new and patented fuel regulator, which cuts off the supply of steam and oil from the burner when the steam pressure in the boiler reaches a point where it has been previously set, and admits a supply of both again when the pressure falls below that point.

We now come to the engine, which is a double crank vertical one, and, up to the 10 h. p., is mounted on the same base with the boiler. The main valve of the engine is of the rocking type and balanced. The motion of the valve is obtained by an intermediate rocker arm, which brings all the work and strain in a straight line with the crank shaft. By the use of the rock shaft the motion is short, enabling the engine to run at a high rate of speed without strain or jar. An important feature of the stationary engine is the Pierce governor. Unlike many governors, it affects equally, it is said, both strokes of the piston; hence more uniformity of speed is attained. This engine has proved itself especially adapted for electric lighting. One plant in particular may be given as an illustration, where a 150-light c. p. Sawyer-Man dynamo has been in operation for over a year, run by a 6 × 6 engine. It was run at a speed of 508 revolutions a minute, cutting off at ¼ stroke, and varying only two revolutions as between load and no load. The boiler used was one of those just described, the fuel used being oil.

The Racine engines, from the smallest up to the highest made, show great care and good workmanship. The builders are the Racine Hardware Manufacturing Company, of Racine, Wis.

The Affairs of the Montreal Telegraph Company.

The annual report of the Montreal Telegraph Company was issued in that city, Jan. 7. It contains the following:

"In view of the very full explanatory statement of the position of the company and the nature of its agreement with the Great Northwestern and Western Union telegraph companies, your directors do not deem it necessary to enlarge thereon at this time, further than to put again on record their undiminished confidence in the validity of the security which the company holds for the due fulfillment of the terms of the contract on the part of the Great Northwestern and Western Union telegraph companies.

"Owing to delays that might occur in the payments by the Great Northwestern Company, your directors decided to make the dividends payable on the 3d of February, 3d of May, 3d of August and 3d of November.

"The accounts show the assets, including lines and cables, office equipments, real estate and cash, to be $2,285,772.41, and the liabilities, including capital, $2,000,000; dividends (unpaid and due), $42,525.77. The surplus of property over capital not available is $151,823.85, and the available surplus is $41,422.79. The total mileage to the end of last year was 2,031 miles, and 183 miles have been added this year, making a total mileage of 2,214 miles."

The report also contains a statement of the negotiations with Mr. Erastus Wiman in reference to the proposed reduction of the dividends from 8 to 6 per cent.

Wiring Buildings by Contract.

To the Editor of The Electrical World:

SIR: I have lately come across a case which would seem to involve some slight complication, and would ask you to publish it in order to get the opinions of your various readers upon it.

A firm of wiring contractors having been awarded the contract for wiring a large building in a country town in which there is yet no central station, were directed to wire up the house so that it could be run either from a central station or from an isolated plant. The work is now finished and ready for fixtures, etc., when it appears that the entire building has been wired upon the Edison 3-wire system.

The question now arises, is it fair to consider that this building has been wired according to contract, which contract stated that it should be capable of being run from an isolated plant? Of course this can be done by putting the two outside wires in multiple, but then the question of "drop" would come in, owing to the neutral wire having to carry the whole of the current for one pole, which, from the size of the wire, it evidently would *not* do without putting a very heavy "drop" in the lights.

Again, supposing a central station be started, using other than Edison apparatus (say for instance a local com-

pany adopt the Westinghouse alternating system), and the electricians of the company in order to use the wiring they find in the building, put their converters on it, connected up in regular 3-wire style, how would the fact of the Edison Company having a patent upon that method of wiring affect the right of the local company to use it?

Again, what bearing upon the case would the fact have that the contractors were or were not the regular licensed Edison contractors for that district? As very large numbers of buildings are now being wired as they are built, I think it is time that some definite system was decided upon, and some standard percentage of "drop."

PHILADELPHIA. SYSTEM.

Lightning Arresters and the Photographic Study of Self-Induction.*

BY E. G. ACHESON.

If in the opinion of any an apology is required—and it is thought that such will be the case—for thus presenting a subject that is in any of its parts a reproduction of the experimental work of such authorities as Professor Hughes, Professor Lodge, Dr. Hertz and others, the excuse is offered that the original motive thought when entering into the series of experiments referred to in this paper was a legitimate one—the clearing away of a little fog surrounding some annoying phenomena attending the working of cables of electric conductors. The investigations became so interesting, so striking and suggestive, and some of the results appeared to have such a value, that it was believed they would afford sufficient excuse for this presentation.

While the measurements made during these investigations were not as accurate as it would be possible to obtain with more refined instruments, the probable errors were not so great as to make them wholly valueless, care in the readings and many determinations checking to a great extent the errors due to the crudeness of the apparatus. Appreciating the fact that untruthful results are less desirable than none, owing to their misleading effects, it is intended to impress the fact that the determinations contained in this paper can at best only serve as a possible check upon future work of a more complete and accurate character. It is also to be hoped that they may promote the already lively interest displayed by the scientific world in discharges, and the sometimes oscillatory character of electric currents.

The mass of material and composite character of the work to be presented will necessitate considerable care in selecting the order of presentation, and it is believed that the subject can be more easily followed if the thoughts and experiments succeed each other in the order in which they occurred to the experimenter, and this plan will be followed even when the after thought is of the greater importance.

As previously stated, the primary motive from which followed this series of experiments was the clearing up of some uncertainty as to the cause of a few annoying troubles in electric cables. But, to be more precise, it was desired to determine the cause of the occasional "grounding" and failure of cables used in telegraphic and telephonic service, when to all outward appearances they were perfect in construction, protected with lightning arresters, and immediately before the moment of grounding indicated high insulation resistances. A case of this kind presented itself for solution, in which there were some features of peculiar attraction to an investigator. It was a cable containing five wires about one mile in length, and of that design known as anti-induction, the cross section being star shaped, each conductor having a surrounding wall of lead. It was used for telegraph work, and the conductors were connected at the ends to overhead lines, lightning arresters being provided for the protection of the cable; the terminals of the cable were on poles some twenty feet in height. The ground plates of the arresters were connected to the earth in the usual manner; that is, by wires running down the poles to plates in the ground.

This cable was continually getting into trouble, the conductors becoming solidly "grounded," and upon examination it was found that the "grounds" were caused by little kernels or spots of carbonized insulation. It was at the first moment thought that these had been introduced in the manufacture of the cable, but their repeated formation emphatically declared against this theory and made it imperative to learn the true cause. It was not probable that they were produced by the working current, for they were of comparatively low electromotive forces, while the presence of the lightning-arresters would, in accordance with the prescribed rules of their action, render it wholly unlikely that they could have been produced by lightning.

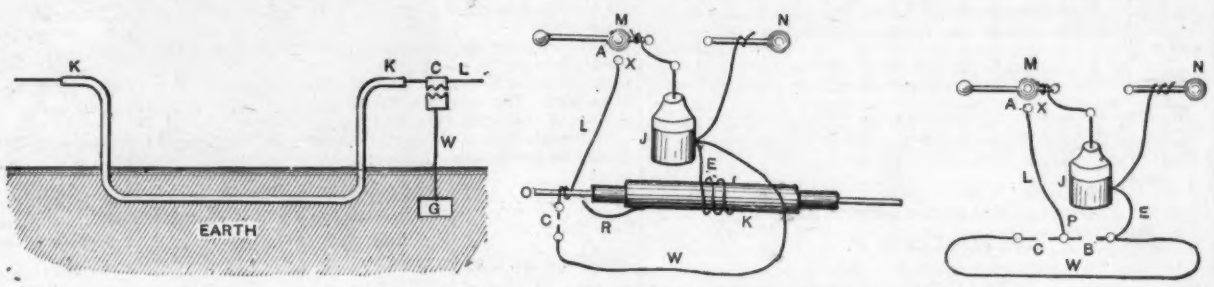
A close study of the experiments of Professor Hughes on self-induction, and of Professor Lodge on the "alternative path" had produced an unsettled condition of my ideas as to the true value of a lightning arrester. The work of these investigators, together with some few experiments of my own, had produced a feeling of interest as to the efficiency of even the best arranged arresters as connected in ordinary practice. I was prepared to believe this to be a practical, live case of a well-mounted and connected lightning arrester not protecting. It even seemed possible that the cable itself was, in reality, protecting the protector, when viewed in the light of Professor Lodge's "alternative path" experiment.

In order to come to some definite and practical conclusions as to the possibility of these troubles having been produced by lightning, a series of experiments was undertaken on lines somewhat analogous to those of Professor Lodge.

In Fig. 1, the general and important conditions of a cable placed in the earth and provided with lightning arresters as usually connected, are outlined. In the figure *K* represents the cable, *L* the line wire, and *W* the ground wire connecting *C* to the ground plate *G*.

It is generally supposed that lightning—or an electrical discharge, as I prefer to call it—produced by the difference of potential between the cloud above the wire *L* and the earth beneath, would, upon striking the wire, pass to the lightning-arrester *C*, jump across the space separating the points to the wire *W* and thence to the earth, or the reverse, as the case may be. But while this is probably the case in many instances, it has not yet been satisfactorily demonstrated that there have not also been many cases were this plan of procedure was materially departed from, the discharge making a path for itself through the cable and the insulation, or perhaps dividing itself between both routes. In order to obtain more clearly defined ideas of the action of a discharge under these conditions, the apparatus shown in Fig. 2 was used, in which it will be seen that the fundamental principles and connections of Fig. 1 are reproduced for experimental work, the cloud being represented by the inner coating of the Leyden jar *J*, and the earth by the outer one, the charge being produced by a Holtz machine, of which *M* and *N* are the conductors. The long length of the cable in Fig. 1 is replaced by a short one *K*. As before, *L* represents the line wire, and in this case is connected directly to the conductor *O* in the cable. The lightning-arrester is replaced by an equivalent *C* composed of two points separated an appropriate distance. The wire *W* is, as before, the ground wire connecting *C* in the former case to the earth, and in the latter to its equivalent, the outside of the jar; the lead covering of *K* is also connected by means of a short wire to the same outer surface. While in Fig. 1 the point on the line *L* which is struck by lightning is subject more or less to accidental conditions, it is in the case of Fig. 2 selected and adjusted by the ball *X*, as is also the value of the energy of action, by the areas of the surfaces on the jar *J* and the length of the striking distance *A*.

With the apparatus arranged as just described and illustrated, it was quickly determined that a discharge could with great ease be caused to pass through the insulation of the cable, even when the space *C* was but a fraction of the distance through the insulation, and the length of *W* a few inches of stout copper wire. The current of discharge seemed to divide itself, a portion passing by *W* producing a spark at *C*, and another portion passing through the cable. A few more experiments also demonstrated that the wire *W* had apparently as much influence on the results as the space *C*, and consequently it became necessary to analyze the



FIGS. 1, 2 AND 3.—ACHESON'S LIGHTNING ARRESTER EXPERIMENTS.

combination more completely to determine the relative values of *C* and *W*. With this object in view the cable *K* was thrown out of the combination, and the connections simplified to those shown in Fig. 3. On close examination they will be found to be in every way similar to those in Fig. 2, with the exception of the replacing of the insulation of the cable *K* with a clear air-space *B*, and instead of connecting *L* to the conductor *O* it is here connected to a post *P*. The spaces *C* and *B* were both adjustable to a fairly accurate degree, *B* being easily readable to thousandths of an inch.

The system of experimentation was to take a certain length of wire *W*, adjust *A* and *C* to known values, and then adjust *B* so

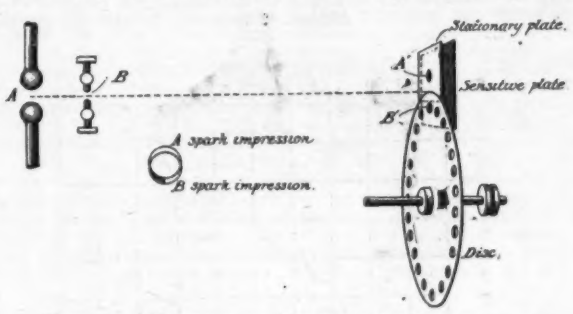
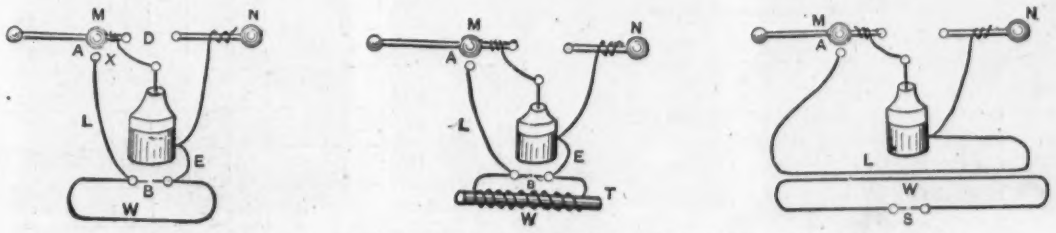


FIG. 11.—METHOD OF PHOTOGRAPHING SPARKS.

that one spark would occur there for about every ten at *A*, and after having noted the length of the spark *B* a few inches would be cut off from *W* and *B* re-adjusted and again noted; this being repeated until *W* was wholly consumed. The values of *B* for these various lengths of *W* and a known length of *C* having been obtained, a wire similar to the original *W* was substituted for the former, and *C* having been removed from the circuit, as shown in Fig. 4, a similar set of tests were made, and the differences between the results, with and without *C*, indicated the true values of *C* and *W* in the combination, while the results with *W* alone show the value of each additional inch.



FIGS. 4, 5 AND 6.—ACHESON'S LIGHTNING ARRESTER EXPERIMENTS.

In plate *A*, Fig. 7, the results of these measurements have been plotted into curves. The length of *W* in inches is plotted horizontally while *B* in thousandths of an inch is laid out vertically. The capacity of the jar *J* was .0025 m. f., and *A* was retained uniformly at .286 of an inch. The full line curve is that of *W* without *C* in the circuit, while the dotted one is that obtained with it in. The length of *C* was .02 of an inch. *W* for both tests was composed of a copper wire having a diameter of .052 of an inch.

A brief study of these curves teaches that, when *W* is but a few inches in length, *C* plays a very important part in determining the length of *B*, and also that its influence rapidly vanishes as *W* is lengthened, and actually produces an opposite effect after a certain length of *W* has been arrived at. Thus, with *W* 20 inches long, *C* has a value equal to 59 per cent. of the total circuit, at 110 inches it appears to have no value, while at 180 inches the value of the compound circuits is about 7 per cent. less than *W* alone. These points are, however, of even less importance than the lesson to be learned from the study of the curve of the results obtained with *W* alone. Here is a case where a relatively small amount of energy contained on the surfaces of the jar *J* will, when discharged into the circuit composed of the air space *A* and the wires *L*, *W* and *E* cause the passage of energy in the form of a spark at the point *B* of a length of over one-third of an inch, and this when the wire *W* is but 20 feet in length, or that of an ordinary ground wire down a telegraph pole.

This does not look very encouraging for lightning-arresters with long ground connections, and rather puts to ridicule the fine adjustment of the points of these devices. The subject will, however, stand more than a little study and investigation before forming judgment, and perhaps the arrester is all right after all, in so far as the close adjustment is concerned, even if the long ground connection does have to go.

Those who are familiar with the recent investigations of Prof. Lodge, investigations so exceedingly interesting and now so celebrated that few there are who have not made themselves familiar with them, will at once have recognized in Fig. 4 connections very similar to those used in the experiment of the "alternative path," by Prof. Lodge. The results obtained by him and in the present experiments are in the main the same, and those differences that do exist are probably to be attributed to the following facts: Prof. Lodge's work was done with instruments of great precision, the sparks were always produced between balls or rounded surfaces, and the object was to determine laws and formulate the mathematics of those laws; while, on the other hand, the experiments now being presented were made in some cases under the most difficult conditions, with apparatus limited to a most exceptional degree both in quality and quantity; a certain portion of the sparks were produced between points, and the object in view was to dissect, analyze, and subjugate the phenomena under examination to and for the benefit of practical work, the every day affairs of the electrical profession.

It is, however, exceedingly difficult to avoid a little speculation, now and then, as the subject unfolds itself, and it is hoped the experimenter may be pardoned for any references that may be made to the theories that have been the immediate cause of some of his researches. It is even hoped that the work performed may atone for the views about to be advanced, notwithstanding the fact that they are quite contrary to those deduced by so high an authority as Professor Lodge.

After a considerable portion of this work had been done and the conclusions more or less formulated, I was much pleased and greatly strengthened in the opinions then being formed to learn through a letter from Professor Hughes to Professor Lodge, published in the London *Electrician*, issue of Sept. 28, 1888, that Professor Hughes had, at least formerly, held the same views of the "alternative path" that I had formed, and which will now be presented in connection with what is thought to be experimental demonstration of their truthfulness.

Referring to Fig. 4, it will be seen, as has already been stated, the conditions and arrangements of *W* and *B* are such as to produce and actually constitute the "alternative path," as shown by Professor Lodge. The simple assertion that they are alternative paths does not, however, make them such, and, while they may under certain conditions and adjustments become so, it is possible to conceive of their being otherwise. Is it not within the bounds of reason to assume that the energy that has been discharged from the jar traverses the wire *W*, and in doing so produces a condition that may be termed *electrification*, and on the disappearance of the controlling influence of this energy, would not the wire *W* return with an almost infinite rapidity to its original non-electrified condition, and, in doing so, produce as the result of this enormous rapidity of motion, an electromotive force at its terminals of a greater value than that of the original energy? In other words, will there not be a restoration of the energy expended in distorting the lines of energy within the wire, and this restoration being performed in a shorter interval of time than that occupied in its production, a higher electromotive force would be obtained even though the value of the return would be less than that of the original, to an extent equal to the losses due to the internal friction of the mass?

This being the case, this current of discharge from the wire, and which was first discovered by Henry and investigated by Faraday and called by him the *extra current*, would, owing to its greater electromotive force, jump the space *B* and thus close its circuit, even when the distance was such as to prohibit the passage of the original current as discharged from the jar *J*.

It seems as though this might be the case, and, if it is, then the discharge that was obtained through the insulation of the cable in Fig. 2 need not have been a part of the original current from the jar *J*, but the current discharged from the wire *W*. If it was, a shortening of *W* would tend towards overcoming the difficulty. To test the case a short wire *R* was attached to the lead and bent out over the insulation so as to present a point to the conductor *O*, the distance between the point and the conductor being about the same as the thickness of the insulation; *W* was now removed, as was also *C*. It will be seen that *E*, the lead of the cable *K*, the short wire *R* and the space separating its end from the conductor *O*, form an equivalent to *W* and *C*. With this arrangement it was not possible to cause a discharge to pass through the insulation.

Now, in accordance with the views which have seemed to me most probably true, this change is due to the reducing of the length of the path *W*, and which is now composed of *R*, *E* and the lead of the cable, this reduction resulting in a subsequent lowering of the potential of the extra or self-induced current. But if the theory of Prof. Lodge's "alternative path" is correct, then the change would be due to a removal from the path *W* of a certain amount of resistance, which has been termed by Mr. Oliver Heaviside, *impedance*.

We here have an apt illustration of inertia under the American and English definitions, as so forcibly stated by Prof. Ayrton. As I have presented it, the spark *B* is the result of inertia, with the American definition—a resistance to stopping. While Prof. Lodge's theory would account for it by inertia with the English interpretation of that word—a resistance to motion.

Accepting the belief that the spark *B*, when adjusted to the critical point, was caused by the self-induction of the wire *W*, a variety of experiments were made with the desire of obtaining experimental proof of the theory. Repeated opportunities presented themselves for mathematical work, and if time and attention could have been given in that direction, the results would unquestionably have been of interest and value, but the work was perforce restricted to the more limited confines of experiment and reasoning. The first experiment of the series was to replace the wire *W* in Fig. 4 with one of smaller diameter, and redetermine the value of *B* in a manner already done for a copper wire having a diameter of .052 of an inch, and of which the results have been plotted in Plate *A* Fig. 7.

Before presenting the experimental results, it is desirable to consider what might be expected from these changed conditions. There will in all cases be practically the same amount of energy discharged into the circuit, for the areas of the condensing surfaces on the jar *J* remain constant, the length of the striking distance *A* also remains of a uniform length; and while it is true that the resistance of *W*, as measured by a Wheatstone Bridge, would vary inversely as the square of the diameter, the resistance of the complete circuit of discharge is, owing to the air space *A*, practically infinite, and hence the relatively trifling resistance of *W*, even when of the finest wire, may be wholly neglected.

The theory that the self-induced or extra current in a wire is a recoil action, is based primarily upon the hypothesis that there exists, before the electrifying current is discharged into the circuit, a prior state—the *electro-tonic* state of Faraday. This *electro-tonic* condition consists in the existence of lines of energy—thermal they may be—with directions coinciding with the radii

* A paper read before the American Institute of Electrical Engineers, at the College of the City of New York, Jan. 8, 1889.

of the wire; these lines or axes of energy being surrounded by circular lines of magnetic force. An electric current being discharged through such a wire would cause,—under the influence of its well-known magnetic whirls or circles, whose planes are at right angles to the line of propagation and, in this case, to the axis of the wire,—a deflection of the planes bounded by the closed lines of magnetic force surrounding the radial lines of energy which are within the wire. The work of producing this deflection would, I think, constitute what is known as the variable resistance which meets a sudden discharge, and which was made the subject of that grand paper on "Self-Induction," by Prof. Hughes, before the Society of Telegraph Engineers, at their meeting of Jan. 28, 1886. This deflecting of the radial lines of energy, while constituting a resistance to the inducing current, is also the source of, or rather, during the act of deflecting, produces, an electromotive force contrary to that of the inducing current. This counter electromotive force exists only during the interval of deflection, and quickly vanishes from the path of the inducing current. On the moment of the interruption of the inducing current, and consequent withdrawal of its attending magnetic whirls or circles, the deflected radial lines of energy swing back to their radial positions, producing by their motion an electromotive force of such a direction as to form a current in the same direction as that of the inducing current. This return swing or recoil, as of a spring suddenly released, is of such a velocity, and overlapping, probably, what might be likened to the tail end of the disappearing inducing current, produces a momentary electromotive force of a value higher than that of the original current.

These being the actions of the forces and energies, it now becomes necessary to understand what differences, if any, the size of the wire through which the original current is discharged, will have upon the value of the induced, or, as it is more generally termed, the self-induced electromotive force. All of the experiments and considerations will be made under the conditions of a constant capacity for the jar J and uniform length of A, and consequently one value for the energy discharged into the circuit. In all cases there will, of course, be a certain amount of the energy that has been discharged into the wire lost and converted into heat. This lost energy will be greater in value in the smaller wire than in the larger in a proportion inversely as their diameters. This greater loss in the small wire and resulting reduction in the available inducing energy would, of course, tend to produce a diminution of the self-induced current. This reduction is, however, exactly offset by the greater concentration of the inducing energy, its inducing value having been increased in a proportion inversely as the diameters of the wires.

It is feared this argument has become tiresome and an immediate relief will be found in Plate B, Fig. 8, where I have plotted two curves; one, the full line curve, is the same as that shown in Plate A, and was produced as formerly stated. The dotted line curve was made with a wire of copper having a diameter of .032 of an inch. The two curves are so nearly alike as to permit of the belief that they are in reality the same, and that the slight differences existing are due to errors of measurement. Here is experimental proof that the electromotive force of the self induced current, as measured by the spark B, remains constant as long as the energy discharged into the circuit is of uniform value, and is wholly independent of the diameter of the wire, and this seems to give countenance to the argument immediately preceding.

It is more than probable that those who have been following the subject closely will, before this time, have had the question asked, from somewhere within: "How would these curves on Plate B have looked had one been made with an iron wire?" The answer is ready at hand on Plate C, Fig. 9. It is not exactly an answer to the question as stated, for there are here shown two curves, one produced with an iron wire and the other with a copper wire, but both are of the same diameter, .052 of an inch. The curve of the copper wire is the one you are already familiar with.

This paper has even now attained to such proportions, and there are yet so many points to present, that nothing more than a moment's glance at these curves can be offered. A study of them teaches that for lengths of 40 inches, copper and iron will, when acted upon inductively by discharges of one value, furnish self-induced currents of like electromotive forces. From 40 to 110 inches they show slightly different values, while beyond this length their efficiencies rapidly diverge; that of the iron running much lower than that of the copper, and apparently fast approaching a maximum. As a means of accounting for these different efficiencies, I would suggest this theory. Up to 40 inches of length the time occupied by the passage of the discharged current was too short to permit of any magnetic effects occurring in the iron, and consequently the wire was equivalent to its neighbor, the copper; from 40 to 110 inches small magnetic effects were produced, resulting in a lag or retardation of the velocity of the recoil deflection of the radial lines of energy, and resulting, of course, in a lowering of the electromotive force of the self-induced current; beyond 110 inches, the time of discharge rapidly increased in duration, and thereby produced the decided flattening of the curve, as shown.

There is one more set of curves to present: They are shown in Plate D, Fig. 10, and were made with the object in view of determining the effect of a variation in the amount of energy discharged into the circuit. Experiments were made with both copper and iron wires, the curve of the copper plotting in above that of the iron one. In the plate, the capacities of J in millionths of a microfarad are plotted horizontally, while the lengths of the B sparks in thousandths of an inch are plotted vertically. The length of the A spark was, as before .286 of an inch. I was prepared to see the B spark increase as the energy discharged increased; but I was wholly unprepared to have it decrease as the result of added energy, after a certain point had been arrived at, and still less prepared to obtain the wavy curves, as shown.

Time will not permit of entering into any considerations of the peculiarities of these curves.

There is a little experiment, the record of which I wish to interline at this point; it may answer a question, and perchance

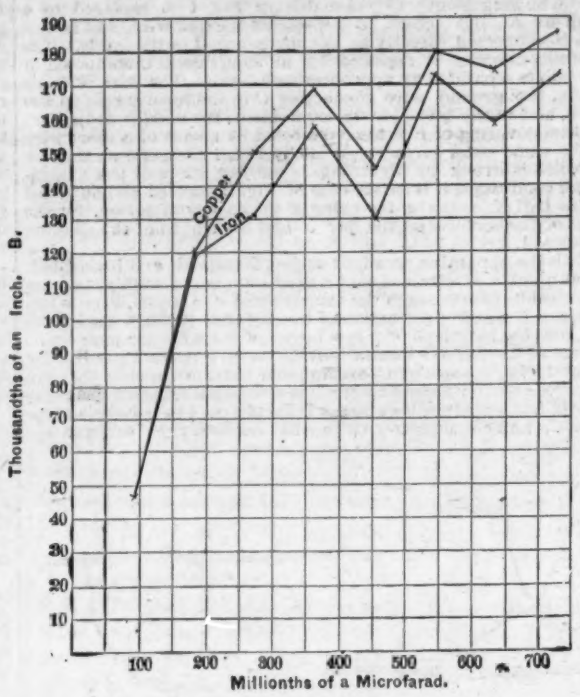


FIG. 10.—PLATE D.

wet the powder of some intending questioner. Looking over my sketches and coming to Fig. 3, the thought struck me that an error might have been introduced into the experiment where the C spark formed a part of Prof. Lodge's "alternative path," due to there being no connection having other than an infinite resistance between the ball X and the outer coating of J, while in all of the other experiments there was the circuit formed by W. It seemed possible that this change might have produced a different value for the energy of the discharged current, as the difference of potential between M and X might be altered. To decide the question, the connections as shown in Fig. 4 were used. The balls forming the terminals of the Holtz machine were caused to approach each other until the discharges occurred about an equal number of times between them at D and at A. Next the space B was adjusted to the critical length. If the existence or non-existence of the wire W and resulting metallic connection between X and J influenced the value of the potential of discharge, its removal ought to lower the potential difference between M and X and cause all of the discharges to occur at D. The experiment, however, did not prove this to be true, the removal or replacement of W having no apparent effect upon the number of the discharges that occurred at A and D; but, of course, when it was removed every spark at A caused one at B.

A few experiments were now made to determine the effect various portions and positions of the parts of the wire W would have upon other portions of itself. The connections shown in Fig. 4 were used. A length of 50 inches of cotton-covered copper wire, with a diameter of .033 of an inch, was used for the wire W. It was arranged in the form of a circle. A was, as before, .286 of an inch, and the capacity of J was .0025 m. f. The critical point of B was found for these conditions, and W was then formed into a figure whose two sides were parallel, and B was measured for various distances between the two sides. These distances were, however, only approximate.

Position of W.	B in inches.
Circle	.182
Sides separated 3¼ inches	.170
Sides separated 2½ inches	.137
Sides separated 2 inches	.137
Sides seprrated 1½ inches	.137
Sides separated 1 inch	.137
Sides separated ½ inch	.114
Sides separated ½ inch	.050

The next experiment, illustrated in Fig. 5, was to take the same wire W and coil it upon a paper tube having a diameter of ¼ of an inch, the wire forming a spiral of one layer about two inches in length. This spiral being placed in the position W the critical point of B was found to be .197 of an inch, or over 8 per cent. greater than when the wire was in a circle. While the spiral was in the last position an iron wire one-tenth of an inch in diameter was inserted into the paper tube, and now the spark B only measured .170 of an inch, over 13 per cent. less than without the iron wire, and more than 6 per cent. less than the plain circle. Another experiment was made like the last, with the exception that the iron wire was long and bent around into a closed circuit, but it did not alter the results. The lowering of the value of the self-induced current upon the introduction of the iron wire was to me at the time startling, but a consideration of the case showed that it should be so, for a portion of the energy of the inducing current was absorbed in producing work in this mass of iron, and of necessity weakened the self-induced current to an extent measured by the work this extracted energy could and would have done in the wire W had it not been withdrawn. I have, however, here a confession to make; I was all of the time considering that this energy was expended in producing magnetic effects in the iron wire until a friend who had called to see some of the experiments suggested that I insert a copper wire instead of the iron one. I did so. The effect was the same as that obtained with the iron wire. The explanation was simple: It was that not magnetic effects, but electric currents closed upon themselves within the wire had been produced. The reduction of the length of the spark B now became a simple question of causing the inducing current to do more or less work external to the wire W, and as another means of causing it to do so, the spiral was surrounded by another spiral of wire with the ends so arranged that they could be connected or opened as wished. With this arrangement, the spark B could be made to come and go, as desired; for by adjusting it to the critical point with the terminals of the outer spiral open, it would entirely disappear when they were united; all of which agrees perfectly with the former experiments and conclusions.

Another short series of experiments was conducted with parallel circuits, as shown in Fig. 6. The lengths of the parallel portions were 35 inches, the distance separating them being .052 of an inch. The total lengths of L and W were 130 inches. A and J were of the same values as heretofore used.

The conditions of the tests and the resulting lengths of the spark S may be briefly stated thus:

Test No. 1	L was copper, diameter .052 in. W " " " "	S = .031 in.
Test No. 2	L " " " " W " iron, " "	S = .024 in.
Test No. 3	L " " " " W " " " "	S = .020 in.
Test No. 4	L " " " " W " copper, " "	S = .025 in.

If my memory serves me right these results are the same, qualitatively, as those obtained by Professor Hughes, and clearly show the apparent sluggish action of iron, both in imparting and receiving magnetic inductive effects. Its relations to these magnetic effects resemble the actions of a polished metal surface when associated with heat; it radiates and absorbs poorly.

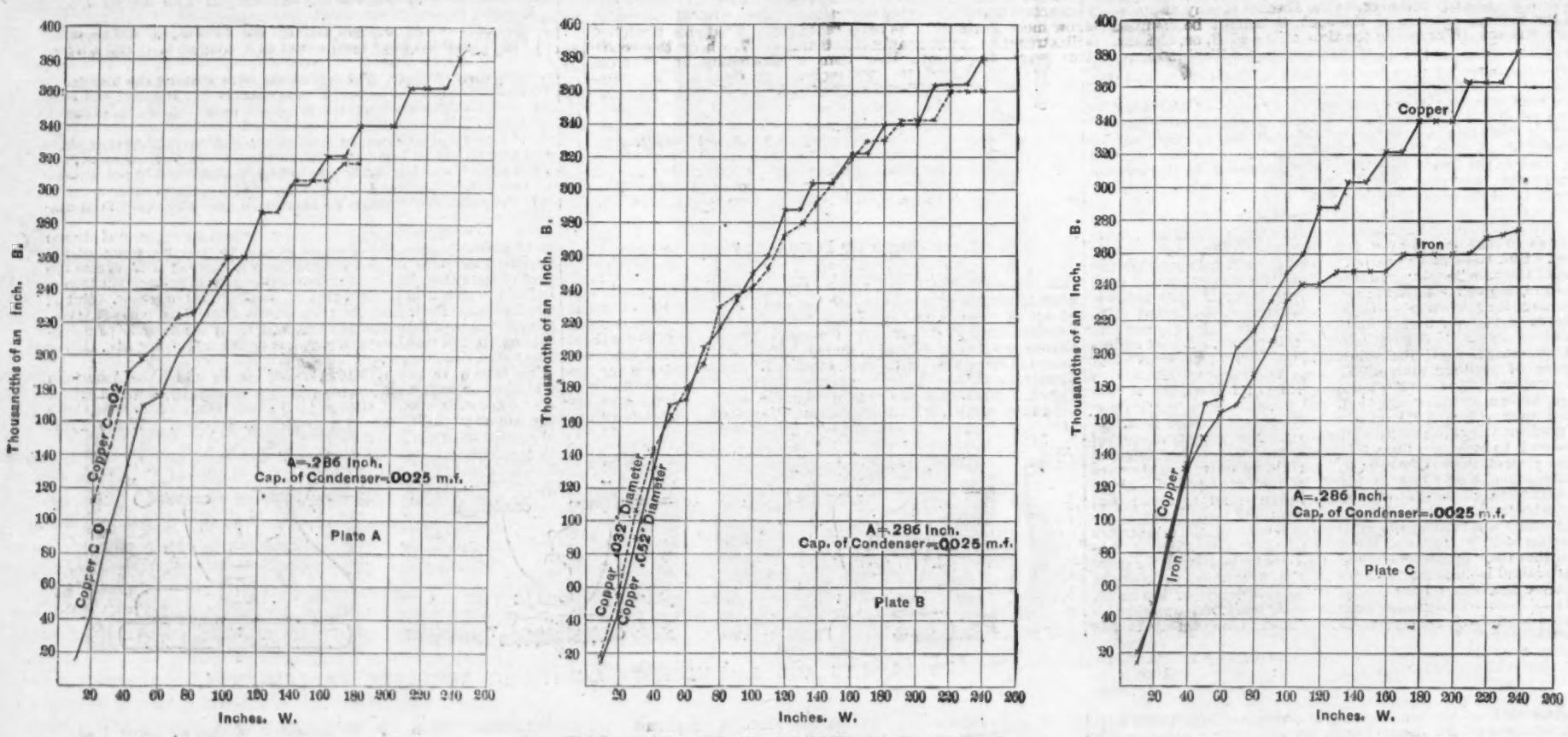
It now becomes my pleasant duty to present the concluding and, at the same time, most interesting and convincing proofs that W is not an "alternative path," but that the spark B is produced by, and consists of, the discharge of the self-induced current. I have called this series of experiments

The Photographic Study of Self-Induction.

Unfortunately, at a late day, a day so late as to prevent my repairing the loss, I met with at least two accidents, and each of them cost me one or more negatives which were a part of the record of these experiments. I shall, however, endeavor to make those remaining demonstrate the desired points.

In making these experiments the end in view was to obtain photographic records of the duration of the spark A, with and without the spark B; with and without the wire W; with various lengths of the wire W, and, if possible, to detect a difference of time between A and B. A disc of tin plate, 20 inches in diameter, was mounted on an arbor and belted to a system of pulleys of such sizes that by working the train by hand a velocity of about 75,000 inches per minute could be given to a circle of holes that had been punched in the disc at a distance of one inch from its edge. These holes were about one-eighth of an inch in diameter and one inch apart from centre to centre. The disc was so placed in relation to the positions of the A and B sparks that a line stretched from A to one of the holes in the upper edge of the disc would pass through B. Immediately back of this same hole a sensitive plate was fixed so that the hole was in front of the centre line, while the plate was removed sufficiently far to avoid being touched by the disc, as shown in Fig. 11.

One half of the sensitive plate projected above the edge of the disc; this upper portion was covered with a tin plate in which a hole was punched of a size similar to those in the disc. The lower portion of the sensitive plate—that is the part back of the disc—was also covered with a tin plate in which a window had been cut a little over one inch square, and in such a position that the



FIGS. 7, 8, AND 9.—PLATES A. B. AND C.

holes in the disc passed in front of it. It will be understood from this description, that while the disc revolved there could be two holes in front of the window, while there could not be less than one. With these adjustments sparks at *A* and *B*, separately or united, would produce an impression upon the sensitive plate, through the upper hole, and through one or two holes, as the case might be, in the revolving disc.

As a result of the accidents above referred to, it will be necessary to introduce the series of experiments with photograph No. 5, Fig. 12, where we have the spot produced through the hole in the upper stationary screen marked *A*, and a spot lower down on the plate marked *B*, and which was produced through one of the holes in the revolving disc. The object in having the spot *A* was that it might offer a means of comparison between impressions made through stationary and moving apertures, and also show the effect of vibrations, if any existed, in the various parts of the apparatus. The value of the energy discharged through the circuit from *J* was disregarded, care, however, being taken that there should be no change in it throughout the entire series of experiments. The velocity of the apertures or holes in the disc was fairly, but not absolutely, determined to be 75,000 inches per minute. With this

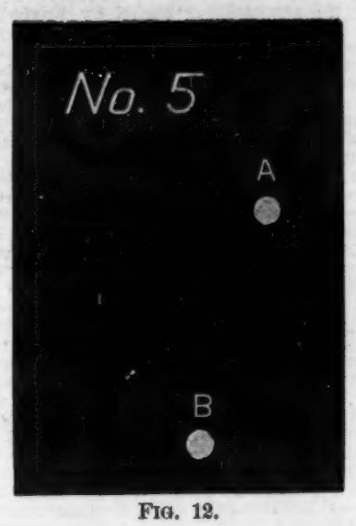


FIG. 12.

velocity of movement, a displacement of the apertures of the one thousandth of an inch would represent an interval of time equal to $\frac{1}{75000000}$ part of a minute.

The series of experiments will be divided into four sets as follows:

Experiment 1, Photo. No. 5, Fig. 12.

The wire *W* was of copper, 76 feet long and .052 of an inch in diameter; the spark *A* was $\frac{5}{16}$ of an inch and was retained at this for the entire series.

The *B* spark was adjusted to a point near the critical state, but, owing to the necessity of its production with the first *A* spark, it could not be set to the same delicacy of action as heretofore. The photograph shows a slightly blurred or indistinct outline on the right-hand side of the spot *B*, which is more clearly brought out by comparison with the spot *A*. From this it is concluded that a measurable length of time was occupied by the spark, as the aperture in the disc through which this *B* spot was produced must have moved an appreciable distance in order to have produced this elongation or "ghost," as the photographic profession would term it. Owing, however, to the absence of any displacement of the distinct outlines of the spot, it cannot be assumed that there was any difference in the time of *A* and *B*, or, at least, not of sufficient value to permit of measurement with this apparatus.

Photograph No. 6, Fig. 13.

In producing this photograph all of the conditions remained the same as those used in photograph No. 5 with the one exception of the spark *B*, which was removed from the circuit by separating the points beyond the striking distance. Here by chance two holes, or rather one and a half, were in front of the window at the moment of sparking, and produced the spots 1 and 2. These spots exhibit displacements that, roughly measured on the negative, are one-tenth of an inch in length, and show a duration of the spark of not less than $\frac{1}{750000}$ of a minute.

From these two photographs the conclusion is drawn that the spark *B* shortens the duration of the spark at *A*.

Exp. No. 2, Photo. No. 7, Fig. 14.—The conditions of the circuit in this case were: Wire *W* shortened to 20 inches in length; spark *B* still out of circuit. This photograph shows about the same length, but darker "ghost" following the spot *B* than did Photo. No. 6, and indicates a corresponding increase in the *work done at A*.

The conditions are the same as the last, excepting that the *B* spark is again introduced. While there is still a measurable duration to the spark, the shortening of the interval due to the spark *B* is very decided.

Experiment No. 3, Photograph No. 9, Fig. 15.—In this experiment the entire apparatus associated with the spark *B*, Fig. 4, was cut out and the outer surface of the jar *J* was connected by a short copper wire to the ball *X*. An examination of the photograph indicates that *A* existed for an interval of time approximately equal to that of a like experiment (photograph No. 8, Fig. 16) and very much less than that shown in photos. Nos. 6 and 7.

Photograph No. 10, Fig. 17.—In this case the wire *W* was removed and the spark *B* adjusted to about $\frac{5}{16}$ of an inch. There seems to be, possibly, a very slight increase in the time over that of photograph No. 9.

Experiment No. 4, Photograph No. 13, Fig. 18.—To this photograph special attention is invited. The conditions under which the negative was produced were wholly different from the foregoing. The tin plate covering the upper half of the sensitive plate, and which carried the aperture through which the spots *A* were made was removed, the plate was lowered, so that a point represented by the spot marked 1 came on a line with the apertures in the disc. The wire *W* was composed of 50 inches of cotton-covered wire like that used in some of the earlier experiments, and was formed into a circle. The *B* spark was removed and was not used during this set of experiments. The *A* spark was, as before, $\frac{5}{16}$ of an inch, and the spot 1 in the photograph is its impression through an aperture of the disc, and, as readily seen, shows a very considerable duration of time.

The sensitive plate was now elevated a little, the wire *W* was coiled into a spiral, as described in a former experiment, and the spark *A* was once more caused to pass. Spots 2 and 2′ are the impressions produced by it, and, as will be seen by close inspection, exhibit longer "ghosts," and consequently a greater interval of time, than was shown in spot 1. Once more the sensitive plate was moved upwards, and an iron core having been inserted into the paper tube upon which *W* was coiled, the spot 3 was produced by another spark, the "ghost" produced being smaller than either of the former ones. These three experiments show conclusively that the presence of the wire *W* in the form of a loop or circle in the path of the discharged energy, tended to prolong the action upon the sensitive plate; next, that the coiling of the wire into a spiral increased the duration of that action, and lastly, that the introduction of the metallic core into the coil, and consequent stealing away of a portion of the discharged energy, shortened the time of action to an interval less than that of the loop.

The field opened up by these photographs for theorizing and speculating is a very broad and rich one, but the time is now too short to more than indicate the manner in which these results add strength to the conclusions deduced from the former experiments. Applying to the photographic experiments the theory already advanced, that the *B* spark was a discharge from the wire *W*, it is found, as would be expected, that when *B* is absent the self-induced current discharges into the jar *J*, producing in its passage a spark at *A*, this spark following immediately upon the heels of the original *A* spark. The jar being in this manner recharged, but, of course, in the opposite direction and of a slightly lower potential, will again discharge into the circuit—the discharge at a reduced potential being facilitated by the thermal and, possibly, magnetic conditions of the air space *A*, and which were produced by the first spark.

This second discharge will leave the jar *J* once more charged, and will be followed by other discharges of a continually decreasing value, until the energy has been dissipated as heat or into other forms of energy through and by the various portions of the circuit. This subject of the oscillating discharge has lately received, at the hands of Dr. Hertz, a masterly and most highly interesting treatment.

Referring once more to photograph No. 6, Fig. 3, which was produced by an *A* spark with *W*, composed of a copper wire 76 feet in length, the impression produced by the original, or first spark, is clearly defined, while in its wake is traced the track left by the sparks produced by the rapidly weakening, oscillating, self-induced currents—a track fading away like the tail of a comet, to an invisible end.

The next step in the inquiry is to determine the effect of introducing the spark *B*, and for this purpose reference will be made to photograph No. 5. Here we find, as would be expected, that the comet-like tail has almost disappeared, the natural result of having offered the self-induced currents from the wire *W* a means of short-circuiting themselves across the points at *B*. The slight trace of a tail—a blurred outline—is to be attributed to the self-induced currents of the portions of the discharge circuit lying between the points of *B* and the surfaces of the jar *J*.

Shortening the wire *W*, with the spark *B* removed, should have the effect of increasing the amount of energy dissipated in the air space *A*, and further than this there should be little or no alteration. This increased amount of dissipation at *A* may be popularly explained thus: The total circuit into which the energy contained in *J* is discharged, and which consists of the space *A*, the wire *W* and the connecting wires, constitute the bodies or spaces from which the energy is radiated or dissipated; and, therefore, any contraction due to removing a portion of them will, of necessity, throw more work upon the parts remaining. That this is correct is illustrated by photographs No. 6 and No. 7, where the conditions were the same, other than a shortening of *W* from 76 inches in No. 6 to 20 inches in No. 7. A comparison shows that while the length of the "ghosts" are practically the same, that of No. 7 is heavier—more material. In the same manner in which the work was increased in the space *A*, so will it be increased in the wire connecting the points at *B* to the surfaces of the jar *J*, and for this reason the introduction of the spark *B* should not be expected to cut off the tail from the spot *B* to the same value obtained with a long wire at *W*. This is the case, as is shown in photograph No. 8, where *W* is 20 inches and *B* has been returned to the circuit. If the "ghost" shown in photograph No. 8 was due to the self-induced currents in the connecting wire, as has been assumed, then the same results should be obtained by cutting off the entire portion of the circuit represented by *W* and the apparatus associated with the *B* points, and short-circuiting these connecting wires. That this is the case is shown in photograph No. 9.

Cutting out *W* and replacing *B* did not seem to alter the results very much, if any, from those last mentioned, and this is just what would be expected.

In photograph No. 13 it is demonstrated that the coiling of a wire into a spiral tends to cause a retention of the energy within itself, and is due probably to the gathering up of a portion of the energy radiated or dissipated by one convolution by the adjoining convolution, and thereby restoring it to its own mass. This retarding of the process of dissipation will result in a prolongation of the time of *A* and consequent action on the sensitive plate, as is shown by the increased length of the "ghost," following spots 2 and 2′ over that following the spot 1. As would be expected, the length of the "ghost" is immediately contracted upon increasing the rate of dissipation of the energy as results from the introduction of a metallic core in the coil of *W*, as is illustrated in spot 3.

The final conclusions to be drawn from these experiments are:

1st. The "ground plate" of a lightning-arrester should be connected to earth by as short a connection as may be possible.

2d. When an air line connects to a cable, a lightning-arrester should be provided and attached to the armor of the cable by a connection not more than a few inches in length.

3d. When a short "ground wire" cannot be used, one formed of a number of strands may be used, and preferably not twisted into a cable.

4th. Any method by which a portion of the discharged current which passes over the "ground wire" may be withdrawn, will tend to increase the efficiency of the arrester.

5th. Under conditions similar to the tests, copper or iron may be used with equal efficiency, when the lengths are under forty inches, and over this length iron is more efficient than copper.

6th. The resistance of the "ground wire" is of little consequence, but it should have a size sufficient to carry off the charge without overheating.

7th. The insulation in a cable may be punctured by lightning, either by the direct discharge, due to the points of the arrester being too far apart, or by the current of self-induction from the "ground wire," when that wire is of any considerable length.

8th. Dissipation of the energy of discharge reduces the self-induced current.

DISCUSSION.

Dr. MOSES: There are one or two things that might tend to start this discussion which I will suggest, so that some who are

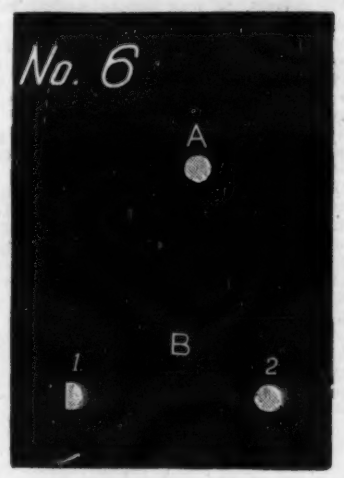


FIG. 13.

present here, who I know have taken great interest in this matter, may continue it. If Mr. Acheson will look at Fig. 2 in these various experiments with the Leyden jar he will remark, where he has a wire coiled around the metallic coating of the conductor, that he has substituted there a supplementary coil of two or three turns, and has brought the terminal of it to a certain distance from the interior conductor. He has done that, as I understand, as a substitute for the wire *W*, in both cases making the air space the same. Will Mr. Acheson please repeat what was the object of that substitution, so that I may direct another question afterwards?

Mr. ACHESON: Dr. Moses is mistaken in regard to its being the equivalent of the wire *W*. In order to ground it I have assumed that the outer surface of the jar *J* represents the earth and I connect the outer surface of the lead to that by a short metallic connection in order to reduce it to one potential, as we would have it in practice.

Dr. MOSES: Were the lengths of the two wires different, that is, the one *E* wrapped around the lead coating and the wire *W*?

Mr. ACHESON: No, sir. The coil of the wire *E* about the lead in this case was probably accidental in the sketch, because in reality it was only one turn around it, so that there was no parallel effect there.

Dr. MOSES: You mention in one case that you experimented with copper and iron wire and used wires of the same diameter in both cases. Did you take into consideration at all the conductivity of the wires, or did you think that unimportant?

Mr. ACHESON: No; I made no measurements whatever of the conductivities. Owing to the existence of that air space I assumed it was wholly useless to consider the resistance of the wire, as we had an infinite resistance already in the circuit; I mean in the space *A*.

Dr. MOSES. In that space *A* did you consider the difference in the size of the condensing surfaces of *N* and *A*?

Mr. ACHESON: Yes; I attempted to make a measurement of the capacity of the apparatus with the jar removed; but although I had a constant on the galvanometer—a very high constant—I failed to get any capacity, not because there was none there, for we know that there was, but it was beyond the reach of my instruments. The size of the balls was considered of course, and the ball *X* was made of a size that would allow me to obtain a sufficiently high electromotive force without spinning off, as it would do where it was very small.

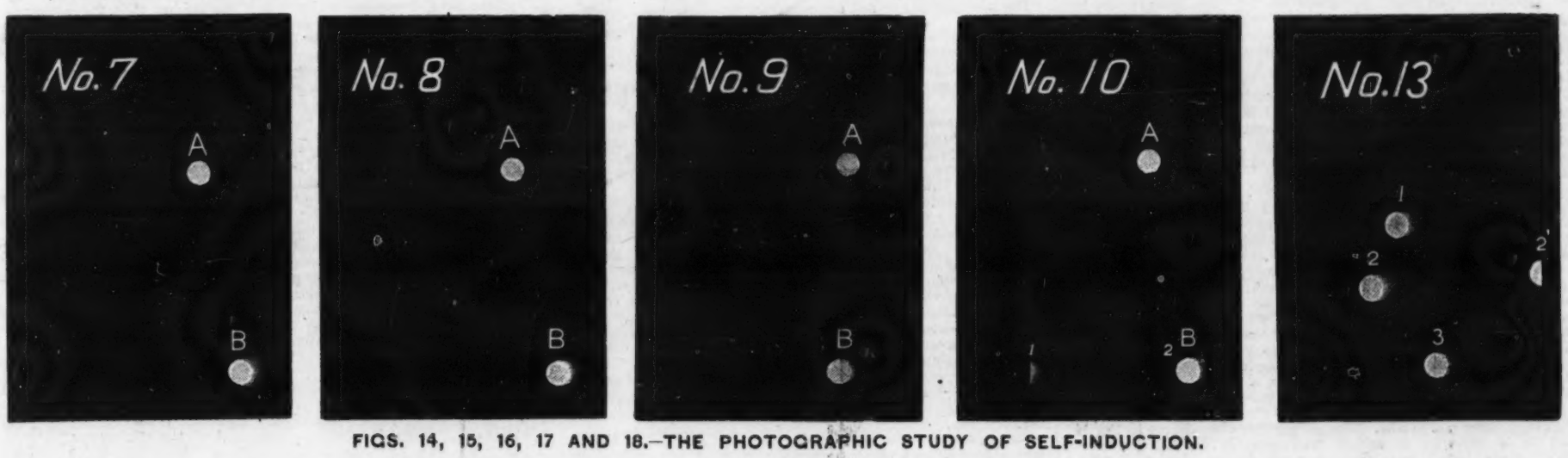
Dr. MOSES: By what means did you cause your rotations?

Mr. ACHESON: By hand. I used in fact Mrs. Acheson's sewing machine as the motive power.

Dr. MOSES: In plate No. 13, when you shifted the machine.

Mr. ACHESON: Well, I shifted the position of the sensitive plate, Fig. 11, my revolving disc remaining in its former position, the disc rotating. Immediately back of it was my sensitive plate, and in order to produce this first spot marked 1 I had the plate in a certain height, and raised it higher for the succeeding ones twice.

Dr. MOSES: Has it ever struck Mr. Acheson that perhaps these experiments might have great bearing on the subject of sparking in the brushes of dynamo machines? These might be avoided by inserting shunts between the brushes, looping the brushes together instead of making them direct in contact so as to be able to time



FIGS. 14, 15, 16, 17 AND 18.—THE PHOTOGRAPHIC STUDY OF SELF-INDUCTION.

the sparks. The power there of avoiding the spark might enable you to avoid the spark on the brush, which comes evidently from the same cause. In the paper in which Professor Hughes described these experiments to which you refer he indicated that there might be some difference in the metals that were used for brushes. There had been experiments carried on in this country before then in that direction; but it seems to me it would be quite a prolific field of investigation to find out whether by alternating brushes, perhaps of iron and copper, you might not be able to eliminate the spark from the dynamo machine.

Mr. HAMILTON: One question arises in my mind—whether or not the ghost, so-called, in the photograph might not have been caused by a difference in the revolution of that disc. It seems to me that the experiments with no possibility, as I can understand it, of accuracy, as to velocity of revolution, might possibly result in this ghost filling the plate.

Mr. ACHESON: I neglected to state the manner in which the disc was timed. I timed it always, but, of course, I could not get an exact speed. The cuts are not printed exactly like the negatives. While some of them exhibited a little, or no, ghost at all, others exhibited a length of as much as a tenth of an inch. Now, we know there is no difference in speed like that.

Mr. HAMILTON: How did you control the speed?

Mr. ACHESON: Well, it was pretty nearly the limit of my power. I had everything ready for the discharge of the jar, and held that in waiting until I had the speed up with my watch before me. I worked with a treadle, so that I had perfect control of it, and worked it up until I had a revolution of the band wheel of a certain value, of which my note-book gives the record in each and every experiment.

Mr. HAMILTON: The photographs were each separate, were they not? For instance, in No. 5, *A* and *B* were the photographs taken at different times?

Mr. ACHESON: The *A* and *B* spots were made by one spark at the same instant of time. The spot *A* was produced through a stationary aperture, while the spot *B* was produced through the moving aperture in the disc. It was a question that I wanted to decide for my own interest to determine whether any vibration that might be introduced in the work would cause any movement of the outlines, and I always had the *A* spot for that object, so that I might have a means of comparison with the spot produced by the moving aperture. I am sorry that these are not an exact print of the negatives, but I presume we never will have them. I do not suppose that they could be reproduced exactly. Even if the plate is good the printing will disfigure that; it will always be the same, and the differences between them are very slight, at most.

Mr. SERRELL: I would like to ask Mr. Acheson if he developed the negatives all at the same time, that is, with the same developer, and gave them all an equal length of time in developing. This ghost or tail is a vanishing thing, and if the development was applied at different lengths of time it would make a different depth to the negative and make a different length to the tail.

Mr. ACHESON: I am not a photographer by profession, and in fact I never did any photographing until I commenced this work. I never had an instructor. I bought my supplies in a store and used a small hand-book as a guide. I think I spent probably fifteen or twenty dollars in buying developers and plates, until I accumulated quite a stock. Although I spoiled some plates, each and every one of them was developed separately, and it was all done after night. None of this work was done by daylight. Much of it was done in the neighborhood of midnight or later, and, as a rule, after considerable experience, I developed them until they ceased to show any increase.

Mr. BIRDSALL: In taking pictures on glass plates, such as Mr Acheson took, although these probably do not exhibit that defect to any extent, a glass sensitive plate pointed at any bright object and a picture taken of the bright object, will always exhibit this halo, and taking a picture through a hole like that, if the source of light were not perpendicular to the surface of the plate, it would exhibit that halo on one side. If the spark was not far enough away from the surface of the plate so that both the holes *A* and *B* were practically in a perpendicular line, that property which is called halation of plates and which is avoided in the paper negatives would introduce probably an appreciable error

Mr. WETZLER: There is one point that occurs to me in connection with the experiment, Fig. 5. Mr. Acheson remarked that when he placed an iron rod in the coil the spark was very much diminished. He attributed this at first to the magnetization; but when he inserted the copper he found the same diminution of spark. He then came to the conclusion that the retardation was due to the energy abstracted from the circuit by electric currents set up within the bar. It seems to me that that result, the equal action of iron and copper, might have been predicated when we consider that it takes some time for iron to magnetize. In other words, the iron would not, as a rule, magnetize to any great degree with a current of a static discharge on account of its great rapidity. The static discharge is practically instantaneous; while it takes some time for iron to fully magnetize, the time being something in the neighborhood of one one-hundredth of a second, if I remember rightly. We may, therefore, conclude, as Mr. Acheson says, that the diminution of the spark was not due to the magnetization of the iron, but was probably due to electric currents set up in it.

Mr. ACHESON: I quite agree with Mr. Wetzler in regard to those opinions, and they are such as I finally formed. It was wholly due to the wonderful rapidity of the discharge and the want of time for it. A gentleman brought up a question in regard to the possibility of a production of those ghosts due to the line of the ray of light not being perpendicular to the glass surface. At first I had some difficulty, and thought I had achieved success before I did, owing to the fact that my two sparks and the holes through which they were taken were not in a direct line, and it caused a distinct overlapping of the outlines of the sparks as produced very distinct and sharp in the spot. At first I thought it was a difference of time between the two sparks; that the *B* spark was a little back of the *A* spark, which was what I wanted, and I was much pleased. But this was not the case; it was simply due to the fact that they were not in line. The *A* spark was as shown in Fig. 11 and at a distance from it was the *B* spark, and in a direct line; as I say, I found it to be direct absolutely. The disc was mounted on bearings as shown and above it a stationary plate with a hole in it. Now, I divided the distance between the two holes so that a line drawn through the sparks *A* and *B* would strike about midway between the two, as shown in Fig. 11. If I caused it to strike the spark *A* it would produce a distinct difference in the spots, as can be seen on some of my negatives; although I tried to get them exactly balanced, under no conditions could I get this ghost. If that was due to the causes which were suggested it should appear in the spot *A*, but it is not there.

Prof. GEYER: I was unfortunate in not hearing the whole of this paper, and I am not sure that I fully grasped it. I hope I may be pardoned in asking a question for my own information. To what cause, Mr. Acheson, do you ascribe the ghost? I am not sure that I quite caught that.

Mr. ACHESON: It is due to the oscillation of the current and the continuous charging and discharging of the condenser surfaces, which has to go through the space *A*, as illustrated in these figures, producing a spark continually diminishing in flow and continuing for a certain length of time until that energy is expended in some manner. On the negatives you can see that the spark weakens and fades away until it actually disappears. You cannot give it a definite length. You cannot set an end to it. You do not know where *it* ends and *nothing* commences, due to that diminishing of the amount of energy, which is oscillating backward and forward in the circuit.

Prof. GEYER: I know of an analogous experiment, which I think proves that the position you take is perfectly correct, and that it is not necessary to find photographic causes for the ghost. The experiment, I recollect, was one made by Prof. Mayer, of the Stevens Institute, in which a Leyden jar was discharged through the prongs of a tuning fork, at the end of which there was a little pointer, which again moved over a rotating cylinder coated with lamp black. When the Leyden jar was discharged, there was made on that blackened paper one great blotch where the lamp-black was dissipated. At the same distance, further on, the cylinder rotating with uniform velocity, there was another blotch, and then there were three or four, and then there would be a moderate interval; then there would come a great group of them, and then another group, so that taking the trouble to count them, there were actually several hundred of those discharges recorded, with no possibility of any photographic disturbance on the cylinder, and showing that there were at least 700 of these oscillatory discharges.

Mr. CUTTRISS: I would like to ask one point from Mr. Acheson in regard to these diagrams as taken from the negative. You will observe in both of them that there is a full light circle and then a tail. Now, I would ask if that was so on the photograph, or was it not a gradual broadening up without any abrupt line between the bright part and the other? It would appear to me as though there was at the final discharge a greater volume of light or a more intense passage of current just at that distance to photograph the true hole and show it across the table.

Mr. ACHESON: If I understand the gentleman correctly, he wants to know whether the outline of the aperture in the disc is clearly defined? It is, if that is the question. On the negative it is clearly defined, You can see perfectly all those outlines. I think that you are correct in assuming that the first discharge is vastly greater than any succeeding one. That outline is shown on the negative.

Mr. GARRATT: I should like to ask Mr. Acheson if the plates were all of one make and number.

Mr. ACHESON: Yes, sir, they were all of one make, No. 26.

Mr. GARRATT: I have occasionally worked with plates myself, and I see no reason, under these circumstances, to suppose that the tail of light is not correct. I do not see any elements of error there. In regard to the speed of rotation, some of these are only half the length of the others. I do not know with what degree of regularity Mr. Acheson can revolve a sewing machine wheel, but I should suppose that he would be able to eliminate an error of 50 per cent.; that is, if he worked it as hard as he could, and was in equally vigorous condition during all of his experiments. I see no reason to suppose that a very considerable degree of error was introduced there.

Mr. BIRDSALL: My suggestion in regard to the spot of light showing the entire circle of the hole and then fading away, is that the first spark of the continued series of sparks which formed the discharge might be the one which has the most energy in it in the form of light due to conditions of the air, such as burning the dust between the poles, or anything like that; and then the succeeding ones might have as much energy in them although not so much of that energy in the form of light, but more in the form of heat or other forms of energy.

Mr. SERRELL: I would like to ask Mr. Acheson which way his wheel turned around, whether the tail was due to the wheel gradually cutting off the light on the plate, and the spark being produced by duration, or whether the first bright spot was due to the first flash, and the wheel went in the direction of the tail.

Mr. ACHESON: The aperture moved in the same direction in which the tail faded.

Mr. CUSHMAN: I should like to ask Mr. Acheson whether the photographs through his moving disc were always photographed through a permanent diaphragm.

Mr. ACHESON: It is the *A* spark that produced both—that is, the *A* spark when it was formed alone produced both spots *A* and *B*. If the *A* and *B* sparks were together, they united and formed these two spots; but the *A* spark always assisted at least in forming both the *A* and B sparks. In the same way, when the *B* spark was produced, it likewise formed a portion of each.

The CHAIRMAN (Mr. F. W. JONES): This certainly is a subject in which gentlemen in almost all the various branches of the electrical profession have some interest, particularly in the department with which I have been identified, where we find these antagonistic currents in our relays, in our cables and in our wires. It causes us a good deal of trouble to find just how they act and also to overcome their bad effects; particularly in relays where the signaling current passing through the various convolutions arouses this antagonistic current and causes them to act very slowly. It changes the character of the signals entirely. I think probably with suggested in dynamo machines, this current has a great deal to do with almost every electrical apparatus. I do not see how you can avoid it. I do not know that I am ready to express any opinion as to the basis upon which the able lecturer has given his opinion to-night. I think, however, that he is pretty nearly correct as far as I have reasoned out the thing up to this point.

The meeting adjourned after giving Mr. Acheson a hearty vote of thanks.

The Thomson-Houston Electric Road, Nashville, Tenn.

The Thomson-Houston Electric Company has just closed through Mr. H. N. Curtis, its New York agent, a contract with the McGavock & Mt. Vernon Street Railway, of Nashville, Tenn., for the equipment of a part of its road. The length of the line is 3.07 miles, of which 2.30 is double track, and .77 single, making a total length of single track 5.37 miles. There are seven curves on the line and numerous grades, the maximum being 5½%. There will be six cars, each 16 feet in length, capable of carrying 75 passengers, and equipped with two 10 h. p. Thomson-Houston motors. The overhead system will be used. This contract was not entered into until all the various systems now in operation in the United States had been carefully investigated. Electricity will not be used on the entire line at present, but a loop will be made from Cherry street around by the Public Square back to the stables. The time consumed by a horse car making this trip is 70 minutes. The new car will make this run in 30 minutes. The consideration of saving one-half of the time is a material one, viewed from both the standpoint of the company and that of the patrons of the road.

Eight cars are now used on this division, and as the new motor cars will be twice as fast, only four of them would be needed, but for the fact that the company expect an increased patronage, so that the six cars will be put on as soon as ready. The City Council some weeks ago granted the right to exchange animal for electric power to all the street railway companies, and if the present road proves as successful as other roads operating this system, the remaining branches of the McGavock & Mt. Vernon road will be equipped, and it will, in all probability, be adopted by the East Nashville and South Nashville companies.

A Blizzard on an Electric Road in the West.

Last week one of the severest tests to which an electric railroad can be subjected was, it is stated, experienced by the Davenport line, installed by the Sprague Electric Railway and Motor Company, of New York, at Davenport, Iowa. It is regarded as proving conclusively that an electric railway can be operated even under the most adverse conditions of weather.

The blizzard which had been howling about the Dakota prairies during the first part of last week, and getting up its strength by snowing in the territory farmers, decided to come south, and on Jan. 9 struck the city of Davenport. The snow, which was of the heavy damp variety, fell all day and covered the streets to the depth of from four or five inches to one foot on a level, and in several places caused deep drifts over the line of the electric railway. In spite of this, the cars on the road kept running uninterruptedly, carrying a large number of passengers and showing that no amount of snow could prevent them operating on schedule time.

The President of the road, Mr. W. L. Allen, was greatly pleased with the signal triumph of the electric system, and is enthusiastic over electric railways. This road has been in operation about four months, and has been giving very great satisfaction to the management and citizens of Davenport, who have had a much better service since its installation than they ever had while the road was being operated by horses. The cars move faster, are under more quick and perfect control, and are much more easily managed than the cars drawn by animal power. The overhead wires used are No. 6 silicon bronze.

Mr. Frank W. Jones' Views on Electrical Executions.

At the meeting of the Medico-Legal Society on Dec. 12 last, Mr. Frank W. Jones, being called upon to state his views on the subject of electrical execution, took exception to the method recommended by the society in its report. In a letter addressed to Col. R. G. Ingersoll, Mr. Jones elaborates these views and gives the results of some experiments upon which they are based. We give below an extract of the communication:

"On Nov. 14 the committee made its report to the Medico-Legal Society, the report being signed by Frederick Peterson, Chairman, J. Mount Bleyer, Frank H. Ingram and R. Ogden Doremus. The report states: 'The manner of the application of the lethal current requires some thoughtful care and study.' It then says, referring to some other experiments instituted by the hononorable Commission, that 'this method, although successful, is hardly applicable to a human being.' This shows how conscientious the committee intends to be in dealing with its grave and responsible duties, and also shows a fearlessness in constituting itself judge and jury on what was not hammered on its own anvil. The report next states that 'the resistance of these dogs was measured and found to vary from 3,600 to 27,500 ohms.' This means absolutely nothing. The resistance of a dog, measured with one cell of battery or one volt pressure is entirely different from that with 10, 100 or 1,000 volts. Of course it is impossible to tell what a dog would measure with a current so high as 1,000 volts, unless special apparatus were used. The report says: 'It is evident, therefore, that the larger the surface of the electrode applied to the body the greater will be the resistance.' Just the reverse of this is the fact, according to all experience and existing text books. The report further says: "It is also a fact that the density of the current depends upon the superficial area of the electrode; a pole of small diameter will hence meet with less resistance, the passing current will be more intense and the resulting current strength will be greater than when an electrode of large sectional area is applied.' This is all grossly absurd, and has not the slightest foundation in fact.

"Then comes this statement: 'The average resistance of the human body is about 2,500 ohms; most of this resistance is in the skin.' As before stated in the case of dogs, this means nothing. The resistance of the skin and tissues of the human body varies as the potential or pressure of the current used in the measurement. To verify this I placed my Thomson's mirror in a bridge, and had my assistant measure my resistance between my two middle fingers, via my arms, and in a series of four tests, the conditions being kept as uniform as possible, we got the following results:

	Ohms.
No. 1 test, with one cell of battery	80,000
No. 1 test, with ten cells of battery	37,000
Second test, one cell of battery	31,000
Second test, ten cells of battery	24,500
Third test, one cell of battery	30,500
Third test, ten cells of battery	21,500
Fourth test, ten cells of battery	17,000
Fourth test, one cell of battery	21,000
Fourth test, ten cells of battery	17,000

"These tests were made at one sitting and the change or decrease in resistance was probably due to the epidermis of my fingers becoming more moistened by the sulphate of zinc solution which I used between them and the electrodes; also, perhaps, to a slight unconscious variation of pressure. This shows a variation of only ten volts to one. Of course I could not stand to have my measure taken with 100 or 1,000 volts pressure through my body, and if the drop was from 21,000 to 17,000 ohms, with an increase of nine volts, what would it have been with an increase of 999 volts?

"Further on the report says: 'There can be no doubt that one electrode should be in contact with the head; the other might be placed upon any portion of the body, but there are obvious reasons why the neighborhood of the spinal cord would be more advantageous.' It is well known that mother nature has admirably protected the brain of man, as also that of many other of his fellow creatures, with a skull or bony case containing the seat of all the organs of sense, and this case forms one coherent mass. No openings or foramens exist much higher up than the auditory meatus all the openings being near the base of the dome. Now bone when dry is a non-conductor of electricity, and in the case of the parietal bones cannot become good conductors. Hair is also a non-conductor as well as the epidermis, which, being very porous, allows moisture to pass through, thus establishing a way for the electric currents to reach the dermis, and finally the fluids and tissues of the body at such points as may be directly included between the electrodes at the apex of the skull and the nape of the neck. It is easy to see that the greater part of the current applied between these points would be resisted by the skull, and would flow around outside through the moisture caused by perspiration, and also under the epidermis through the blood vessels and tissues enveloping the skull, and any fatal effect would arise from a shock similar to a blow at the apex and from a reflex action on the spinal cord through the magnum foramen at the nape. To verify this my assistant made several measurements of me between these points and also between a point near the atlas vertebræ in the back of the neck and a point on the body in front, between the fifth and sixth ribs; calling from the apex of the skull to the nape of the neck *A B*, and from the nape of the neck to the ribs *B C*, the results were as follows:

	Ohms.
A B, first test, 2 volts	31,000
B C, first test, 2 volts	26,000
A B, second test, 5 volts	11,000
B C, second test, 5 volts	8,100
A B, third test, 5 volts	10,000
B C, third test, 5 volts	8,100
A B, fourth test, 5 volts	4,500
B C, fourth test, 5 volts	3,200

"As the direct distance between *A* and *B* is but one-third that between *B* and *C*, it makes the figures given comparative by dividing the measurements of *B* to *C* by three, thus: *A* to *B*, 31,000; *B* to *C*, 8,700. Second test: *A* to *B*, 11,000; *B* to *C*, 2,700. Third test: *A* to *B*, 10,000; *B* to *C*, 2,700. Fourth test, *A* to *B*, 4,500; *B* to *C*, 1,070. These tests seem to indicate that the resistance of the head is proportionately four times greater than the neck and trunk, showing that the bones of the skull must very greatly resist the flow of the current.

"The report advises that the hair and skin of the victim be 'thoroughly wet with warm water.' It is common knowledge that a solution of salt and water is many millions of times a better conductor than water alone. The committee advances a plan of operation in which the subject is laid out on a table and a helmet strapped on the victim's head, from which the hair has been previously shorn or shaved, and that a dynamo alternating current machine generating 3,000 volts be used for thirty seconds. As 800 volts of continuous current is shown to have killed a dog in two seconds, as against three seconds for the alternating, it is difficult to see the consistency of the recommendation. It seems very small play for electric light companies to attempt to make this an occasion to arouse public prejudice against any particular kind of electric current which may be adapted as the most suitable for this disagreeable duty which society has decided must be performed for the public weal. The public does not pretend to decide for itself whether the pressure of steam boilers, with which it is in daily proximity, is dangerous or not; neither can it decide in the case of electric currents used for lighting, power or domestic purposes. Public inspectors must be appointed to decide all these questions and it will make not the slightest difference what current is used at executions. If the inspectors' duty is faithfully performed the public need have no uneasiness about the currents which are contributing so much to our welfare and enjoyment."

Electric Lighting on the Florida Special.

The Florida special Pullman vestibule train, running three times a week from New York to Jacksonville, Fla., is equipped with a new arrangement for lighting the cars. Each car is provided with 32 storage cells of the Electrical Accumulator Company, which are kept charged by means of a neat little dynamo plant situated in a corner of the baggage car. Here there is placed a Brotherhood engine which drives an Eickemeyer dynamo from J. H. Bunnell & Co., of this city, which delivers 80 ampères at 80 volts, and keeps the batteries charged. The whole dynamo and plant, including switches and instruments, does not occupy a greater floor-space than 6 × 8 feet. The exhaust steam from the Brotherhood engine is also utilized for heating the cars.

Each car is wired for 20 lamps, and several novel features characterize the plant. Thus, a very neat addition to the comfort of passengers, and especially invalids, is a plug switch at each seat by which connection can be made with a portable incandescent lamp hung at the side. In this way one is able to read comfortably with the curtains of the berth drawn to. The Eickemeyer dynamos used appear to be very popular with those superintending the work and in charge of it. Their compactness is a great point, their iron jacket is another, and the output per space occupied and weight of machine is very satisfactory.

Resistance of Alloys.

C. L. Weber, in Wiedemann's *Annalen*. XXXIV., 1888, gives the results of some experiments on the resistances of alloys of tin and lead, and tin and bismuth, at high temperatures. Pure tin on melting exhibits a sudden increase of resistance, and a similar phenomenon occurs with an alloy corresponding to the formula Pb_2Sn_7. In the case of other alloys the increase of resistance may be classed under two heads; first, in the case of all alloys there is a rise at (the first melting point) about 180 degrees C., and a further rapid increase of resistance until the fusion is complete; the former rise is the more marked the simpler the formula of the alloy. The alteration in resistance in all cases is somewhere about 50 per cent. For tin-bismuth alloys the case is different; these have all an approximately constant melting point, about 140 degrees C., but differ in their other properties. In the case of alloys containing only up to 12 per cent. of bismuth the melting point is not very noticeable, though apparently a little lower than pure tin; from 25 to 50 per cent. bismuth alloys the resistance suddenly decreases, and then begins again to increase at 60 to 80 per cent. Bismuth shows a steady decrease of resistance during the whole period of melting; the smallest change noticed was in the case of a 54.5 per cent. bismuth alloy, but Herr Weber considers it probable that an alloy between 55 and 60 of bismuth corresponding to the formula Bi_3Sn_4 would have a still smaller alteration in resistance. Temperature coefficients lie between 0.2 to 0.4 per cent., and 0.05 to 0.08 per cent. for the alloys in the solid and liquid state, respectively. Herr Weber concludes from his experiments that the decrease in resistance of bismuth, when melted, is due to an essential property of the metal, and not to an accident of structure.

Theatre Lighting in Paris.

The Chief Commission of Theatres of Paris has recently presented to the Municipal Council a report upon the way in which the measures for security ordered by the Council have been carried out in the theatres of Paris. According to this report the electric light is now almost universally adopted; those theatres which have not adopted the light are waiting solely for the time when permission has been obtained to connect the wires with their premises. The Commission state that they have decided to exact the fulfillment of the conditions that all may be finished before the end of the winter, so as to guard as effectually as is in their power against the occurrence of any catastrophe which would spoil the success of the Exhibition of 1889.

Prepayment Meters.

An addition to the ordinary gas-meter is being introduced by Mr. R. W. Brownhill, of Aston, near Birmingham, by which the penny automatic action is combined with the meter, and small consumers can purchase six or eight hours' supply by the insertion of "one penny in the slot." The light diminishes a quarter of an hour before cutting off. By this means it is expected that thousands of small consumers will be able to have the light. Possibly the hint may be useful to electric light supply companies when the demand for light or power becomes an extensive item of supply, and desire is manifested for extension of custom.

The Chicago Exhibition.

Mention has been made from time to time in our columns of the coming Electric Light Convention in Chicago, which will be held on Feb. 19, 20 and 21, and of the plan, which has now arrived at maturity, of having an exhibition of electrical apparatus and supplies which shall fairly represent the state of the art at the present time, in this country. The Executive Committee of the Association, through its active chairman, Mr. B. E. Sunny, has hired the art gallery and the dining-room of the Exposition Building. Most of the leading manufacturers of apparatus and supplies have applied for space. A number of these exhibits will cover several hundred square feet each, and the latest and most approved electric light and power apparatus will be shown in operation. Most of the leading makes of electrical conductors, both overhead and underground, will be shown under conditions which will be of peculiar interest to electric light and power men. Most of the present forms of underground conduits will also be shown. Engines, boilers, clutch-pulleys, belts, etc., will also be shown in operation. In the large hall, a street railway track, over 1,000 feet long, will be laid, and on it various styles of electric street cars will be operated. It is evident that the exhibition will far excell anything heretofore attempted by the association, and will be of considerable interest and importance to the electrical fraternity and to the public at large. The public will not be admitted, except upon presentation of tickets, which can be freely obtained from exhibitors, and also from the officers of the association. We are informed that this exhibition will be closed during the hours when the convention is in session. We learn from Mr. Allan V. Garratt, secretary and treasurer of the association, to whom we are indebted for the above details, that a number of very interesting papers are already promised, and that several of the committee reports will be elaborate and exhaustive, and will end to profitable conclusions.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, Jan. 14, 1889.

Personal.—Mr. Theodore N. Vail, the President of the Metropolitan Telephone Company, and head of half a dozen other big concerns, has just returned from Europe after a two months' business trip.

Willis & Hunter, 115 Broadway, representing the Eddy motor, are "piling in" the motors at a rare rate. They installed last week some 1, 2 and 5 h. p. machines, and this week some of 7 and 10 h. p., as well as taking orders for two 25 h. p., for the new "Tower" building in this city.

Use of Accumulators.—Mr. H. S. Webb, the President of the Wagner Palace Car Company, has arranged to have his handsome residence, 680 Fifth avenue, fully lighted with a temporary plant, employing nearly 100 cells, from the Electrical Accumulator Company, on the occasion of a grand reception.

The E. S. Greeley & Co. have issued one of the prettiest calendars of the season. It is in black and white, and shows at the top of the large card a coaching party, while to the left is a dainty picture of a New York belle in promenade costume. At the back of the card are illustrations of a number of the firm's specialties.

Mr. Homer Brooke, 44 Barclay street, has a large trade as maker of glass molds, tools, etc., for the leading glass manufacturers in the country. He is a pioneer in the business, has grown up with it, and now, after twenty years' experience, together with command of the best appliances and machinery, he is in the enjoyment of large orders in his specialties.

The Tucker Electrical Construction Company, 35 Broadway, are very busy on construction work in this region. They have lately secured the contract for all the work in the Central Turnverein Building, Sixtyseventh street and Third avenue, as well as all that for the Progress Club at Sixty-third and Fifth avenue. Some orignal ideas are to be carried out.

Jordan & Gottfried, formerly of 208 Canal street, dealers in iron and brass machine wood screws, bolt, cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc., have gone into partnership with H. T. Patterson & Co., of 146 to 150 Centre street, where they will carry on business under the firm name of Patterson, Jordan & Godfried.

The Clark Electric Company, of 159 Chambers street, has issued a very neat and tasteful blue circular on its arc light system, citing the fact that it has been awarded the medal of superiority by the American Institute of this city, and giving in full the testimonials of Mr. J. J. Bockee and Dr. Vander Weyde. A brief and pithy description is also given of the apparatus, including the well known shunt-wound dynamo, the automatic regulator, and the single and double lamps.

The Park City Light, Heat and Power Company, of Park City, Utah, on the 5th inst. contracted with the Edison United Manufacturing Company, through their agent, R. M. Jones, of Laramie, Wyo., for a complete central station for 900 lamps capacity. The station will be a duplicate of the Edison one in Evanston, Wyo., built by Mr. Jones. It is the intention to start up the Park City station inside of 90 days. The engines will be furnished by A. L. Ide & Son, of Springfield, Ill.

The Freeman Dynamo Electric Motor Company, of 89 Liberty street, has the following directors: Warren P. Freeman, president Northwestern Supply Company; N. Denison Morgan, managing director Home Provident S. F. Association; J. W. Merrill, president Globe Stationery and Printing Company; Louis Bauer, manager Equitable Life Assurance Society; Robt. Webb Morgan, actuary Home Provident S. F. Association of New York; Samuel C. Robinson, M. D.; James H. Morgan, special agent Northwestern Life Insurance Company.

The Excelsior Electric Company have a fine incandescent plant at the Freundshaft Club, Seventy-second street and Park avenue. This new club-house is said to be the handsomest in this city, and I must say it is the most scientifically and practically lighted building I have had the pleasure to examine. I was escorted throughout the club-house by Mr. Gessel, the manager. In the sub-basement, set up on solid foundations, are two 500-light dynamos and one 125 h. p. Straight-Line engine, the power being transmitted by two cotton leather belts. I was pleased to see how well Mr. Wm. Hochhausen's new automatic regulators controlled the current. A large number of pencil carbons are set up perpendicularly in a fine wooden case, and connected in the field of the dynamo. When the current varies an electro-magnet is energized, thereby drawing a novel armature, which has rocking or rolling contacts, cutting in and out more or less of the fields of the dynamo. Another interesting feature is Mr. Hochhausen's new switches, to avoid sparking or the formation of arcs at the contacts. An extra spring contact containing a carbon pencil is connected with the lever of the main switches, which, when the lever is drawn from negative to positive or *vice versa*, springs forward making contact first with another carbon pencil, which has not time to get hot before the regular metal switch is brought into contact, thereby avoiding any possible chance of burning or discoloring the metal on the switches. Mr. George H. Pride did the wiring, and it is a good piece of work. Wherever there is any possible danger, "P. and B." paint will be found upon the wires, and all wires, except in the main building, are in plain sight. There are two separate circuits, and either or both can be connected to the dynamos. The main corridor, as you enter from Seventy-second street, is of old oak, finely carved. To the right of the corridor is the ladies' reception room. Further on a large comfortable reading-room. In the southwest corner is the ladies' dressing-room. Left of the corridor is the billiard and pool-room. In all of these the 16 c. p. incandescent lamps were set in most suitable style to conform with the surroundings, and fully lighted; and no extravagant number of lamps is used anywhere. There are 4 over each billiard table. The corridor has 2, 3, 4 and 5 lamp silver brackets, with lamps suspended from them in neat style. The second story is set apart in one immense dining-room to seat 800 people. The chandeliers here are silver-ornamented pendants, with globes at the bottom, surrounding which are a number of 16-c. p. lamps suspended in festoons. The third floor is one immense ball-room, with a stage at one end. The ceiling here is a work of art. Running from the centre are rays of light formed in the plaster, and suspended from the centre is an immense glass ball filled with incandescent lamps. When lighted up it was like the sun throwing out her rays. At numerous points in the ceiling also are stars, being 16-c. p. lamps set in the plaster. Going back to the regions below, we find the "kneipe," or old German drinking-room, where in keeping with the old style oak furniture are two sets of immense deers' horns forming two fine chandeliers, with 16 c. p. lamps suspended from them. The building has "registers" from which you can receive either warm or cold-air, or both combined. The fan or ventilator of this is run by a 20 h. p. N. Y. Safety upright steam engine. I may add that Grimshaw wire is used throughout and that the fixtures were furnished by the Archer & Pancoast Manufacturing Company. W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, 146 Franklin St. and 149 Congress St.
BOSTON, Jan. 14, 1889.

Change of Address.—It will be observed by the above adres that this office has been removed to new quarters.

The Mason Regulator Company of this city, have just ceived a diploma of excellence granted heir valve by the recen National Scandinavian Exhibition held in Copenhagen.

Roxbury, Mass.—The Roxbury (Mass.) Electric Light Company was formed on Monday, Jan. 7, with a capital of $50,000. The plant, when finished, will start up with 2,000 incandescent lights.

New Catalogue.—The Electric Gas Lighting Company, Boston, will soon issue a new catalogue and price list for 1889, which will fully sustain the reputation of this well-known company in the production of neat and artistic publications in that particular line.

Removal of Offices.—B. F. Sturtevant of "Blower" fame has removed his Boston offices and salesrooms from 115 Purchase street, Boston, to 34 Oliver street, corner Franklin. Mr. Sturtevant has had printed an illustrated catalogue of his new automatic cut-off engine.

New Offices Taken.—The New England Wiring and Construction Company, of Boston, is fitting up new offices at the corner of Franklin and Pearl streets. Messrs. Paine & Francis, agents of the Edison United Manufacturing Company will occupy offices on the same floor with the first named concern.

Personal.—Among the prominent electrical people who visited Boston during the past week were the following: Brainard Rorison, secretary Jenney Electric Company, Indianapolis, Indiana; H. D. Stanley and N. M. Beach, of the Bridgeport Brass Company, and George T. Manson, of the Okonite Company, New York.

Schaefer Incandescent Lamps.—A steadily increasing demand for this meritorious product has compelled the Schaefer Electric Manufacturing Company, of Cambrideport, Mass., to add to its force, and even then over time has to be resorted to. The Schaefer lamp deserves its well-earned reputation for long life and its clear white light.

Russell Mast-Arm.—The Russell Manufacturing Company, of Providence, R. I., has contracted with the Marr Construction Company to furnish the city of Pittsburgh, Pa., with mast-arms varying from six to eighteen feet in length. The city of Providence will replace the old style hoods used heretofore on its arc lights with Russell mast-arms.

Novel Electric Cut-Out.—Mr. H. C. Wirt, a young Boston electrician, with office at No. 19 Pearl street, has handed me for inspection a neat and quite novel cut-out for flexible cords. The cord can be fastened to a movable piece on the cut-out, so that a fuse wire or a new cord can be attached or removed at will, without taking down the cut-out.

Interesting to Supply Dealers.—The well known electrical supply house of Pettingell, Andrews & Co., Boston is having a heavy run on two of its several specialties. I refer to the Haynes double-pole incandescent switch and the Boston ceiling button. Both of these useful devices meet the requirements of the Boston Fire-Underwriters' Union.

The Bernstein Electric Light Manufacturing Company has removed its offices from 48 Congress street, Boston, to a suite of elegantly fitted rooms on the first floor of the Hathaway Building, No. 620 Atlantic avenue. The new quarters are rooms F, G and H, and adjoin the incandescent department of the Thomson-Houston Electric Company, directly opposite the private offices of the Sawyer-Man Electric and Westinghouse companies.

The Spencer Damper Regulator has recently been furnished by Mr. G. G. Stillman to the Poughkeepsie, N. Y., Electric Light Company; the Thomaston, Conn., Electric Light Company; the Montpelier, Vt., Electric Light Company; the Westerly, R. I., Electric Light Company; the Fredericton, N. B., Electric Light Company; the North Shore Electric Light Company, Beachmont, Mass., and the Incandescent Company, of Newport, R. I.

The Hartford Dynamic Company, of Hartford, Conn., has issued a useful memorandum calendar. At the top is a fine cut of the soldiers' memorial arch at the Connecticut State Capitol, and below is the pad of memorandum sheets, each one making provision for a week and giving space for a large number of notes and jottings. At the front are given domestic and foreign postage rates, and the last page is a full calendar for the year 1890—an excellent idea.

Handsome Award.—The Franklin Institute has awarded to John Gates, the inventor of the "Sight-feed Lubricator," the "John Scott Legacy Medal" and premium. This invention refers to the Gates's patent method of lubricating the cylinders and internal working surfaces of steam engines by oil automatically fed in visible drops up through a liquid inclosed in a transparent chamber, called a "sight-feed," owned and controlled by the Selbert Cylinder Oil Cup Company, of Boston, Mass.

Stanley & Whittlesey is the name of a new firm recently organized at Pittsfield, Mass., to do an electrical engineering business, more particularly with the Westinghouse incandescent and Waterhouse arc systems. Mr. Wm. Stanley, Jr., who is so well known in the profession, is the electrician of the firm. Mr. W. A. Whittlesey is the manager, and Mr. G. H. Kimber is the engineer and draughtsman. The latter gentleman has resigned as superintendent of the Pittsfield and Peekskill local companies to take this new position.

The Wright Electrical Engineering Company was launched on the 1st of January, and Mr. Wright's many friends meet him with New Year's greetings and wishes for success. Work is already pouring in on the new enterprise, and to-day Mr. Wright has undertaken a work of great difficulty, of which more will be heard shortly. The offices of the company, No. 74 Federal street, Boston, are now being fitted in a neat and business-like manner. They are on the ground floor, with handsome frontage.

National Telephone Manufacturing Company.—This company has already acquired a widespread reputation for the usefulness and reliability of its mechanical telephones. Manufacturers especially find in this product an instrument that "fills the bill" in every sense and purpose for communication, particularly to buildings isolated from the main factory. The company has recently made great improvements in its apparatus. A low tone of voice, even a whisper, as well as the ticking of a watch, can be distinctly heard over several hundred feet of line. Manufacturers will find it worth their while to inquire about this telephone.

Boston Electric Club.—About a week ago the Boston Electric Club inaugurated new officers for the year 1889. They were: President, W. J. Denver; Vice-Presidents, H. B. Cram, A. L. Rohrer, G. L. Lang, Frank Fuller; Secretary, R. F. Ross; Treasurer, F. J. Boynton; Executive Committee, C. M. Ransom, Chairman.

The "inauguration dinner," which is given in honor of the new officers every year, took place Friday evening, Jan. 11, at Young's Hotel. About 60 members of the club and guests were present. President Wm. J. Denver occupied the chair of honor. He also made a brief speech when dinner was over, and was followed by Capt. Eugene Griffin, P. H. Alexander, J. C. Wilson, H. B. Cram, John Post, Jr., George W. Adams and others.

The Thomson-Houston Company.—The Boston *Herald* of Jan. 13 says: The Thomson-Houston Electric Company is about issuing series C pool certificates. They will amount to 40,000, par $25, and will be offered to present stockholders, share for share, at $10. These certificates will be secured by $1,000,000 of sub-company securities, etc., placed in trust and managed for the benefit of this pool. This will yield the company $400,000. Beyond this it is proposed to issue $1,000,000 7 per cent. preferred stock, one-half to go to present common shareholders (there are 40,000 shares) and the balance to be sold at the discretion of the company. The common stock is quoted around 120 (par 25), and receives no dividends, except that which comes through the pool certificates. It will be necessary to secure authority in Connecticut for the issue of new stock.

Sale of the Schuyler System.—For some time past Messrs. Lemp and Wightman, of the Schuyler Company, have been in the Thomson-Houston service, and the outward expression of the state of facts that this situation denotes is found in the announcement that the Thomson-Houston Company has a controlling interest in the Schuyler system, to the extent of about $200,000, besides guaranteeing five per cent. on about $50,000 still held by outsiders. The works will be carried on at Middletown as before. In view of the fact that popular rumor persists in crediting the Thomson-Houston Company with an interest more or less direct in the Fort Wayne, Bernstein and Mather systems also, and that now one hears whispers of a cordial understanding with the United States Company also, it would seem as though Boston was holding her end up pretty well. I simply mention these reports for what they are worth. The denials on all sides are just as numerous and positive.

New Electric Light Station, Salem, Mass.—The Salem, Mass., Electric Light Company is making rapid progress with its new station. The building being located at tidewater will admit of the most economical production of steam power, the great item of expense of electric lighting. This station, when completed, will be well worth the consideration of the electrical fraternity as one of the standard stations of the country. A McIntosh, Seymour & Co.'s engine of compound condensing type, 350 h. p., has been ordered by the Salem Electric Light Company for the new station, and the equipments of the engine and boiler rooms and electrical department will be of the highest order. The designs and plans of the building will be similar to those of the electric light station finished recently for the Cambridge Electric Light Company; and were prepared in detail (as were those for the latter) by the Engineering Department of the Thomson-Houston Electric Company under the personal supervision of its electrical engineer, Mr. H. C. Patterson.

Opening the Danvers New Station.—On Wednesday evening, January 9, the new electric light station at Danvers, Mass., was formally opened by the town authorities. Upward of 60 invited guests were present, and these included the Mayor of Chelsea and other prominent gentlemen from various sections of New England, who, after having been escorted over the station and on a trip of inspection along the circuits, partook of a bounteous supper. Speeches commemorative of this interesting event were indulged in after the supper, and it was nearly midnight, before the party broke up. This electric light plant is said to be the first in Massachusetts sold outright to the authorities. An appropriation of $4,000 was made recently to defray the expenses of running the electric lights the first year. A close estimate of the expenses of the station and lines and lights for the first year will not, it is said, exceed the appropriation stated. There are 72 arc lights of the Brush system; 71 on the streets, and one inside the station. One sixty horse-power Ball engine is used to run two 45 light Brush dynamos. The station is commodious, and the electrical and steam plant equipments are first class in every respect.

West End Railway Works.—On Nov. 20 the Thomson-Houston Electric Company started to equip the Cambridge Division of the West End Street Railway of Boston, running from Bowdoin square, Boston, via Cambridge street, West Boston Bridge, Main street, to Harvard square, Cambridge (three miles), and thence via North avenue to Arlington, a distance of four miles, about six of which is double track and paved. As the season was so far advanced it was first thought advisable to equip the line as far as Harvard square, and accordingly the rail connections were made from Harvard square to Bowdoin square and back. This work was completed Dec. 3. In view of the fact that the cars on this division of the West End Street Railway run on a headway of about one or two minutes, it will be seen that remarkably good time was made by the Thomson-Houston Company in removing the paving and drilling and connecting the rails without interrupting the traffic. The work of connecting the rails on North avenue is now also about done. The poles used in equipping this line are made of lengths of strong iron pipe firmly shrunk together, and are very neat and unobtrusive. There are three styles of these poles, it being deemed advisable to use a stronger one on the curves than was used on the straight stretches—300 have been used from Harvard to Bowdoin squares. They are set in crushed rock and cement. The work of setting poles from Harvard square to Arlington is progressing rapidly, and already about one-third of the distance has been covered. The "cross suspension" method will be used the entire length of the line. The cross wires from which the trolley wires hang have been stretched and are in position from Harvard to Bowdoin squares. The overhead trolley wires will be placed in position this week and the work of fastening them to the cross-arms will be commenced. In order not to interfere with the operation of the car during this work large platform staging will be used, which will permit of the passage of the cars underneath it. In connection with the work of equipping the line, it may be said that the Thomson-Houston Company has had to cope with several unusual difficulties, and in the overcoming of which no little engineering skill has had to be employed. One of these points has been the draw-bridge over which the two railway tracks run. Owing to its peculiar construction and situation, it has been found necessary, in order to effectually connect the wires, to design a special switch. At the grade crossing of the Boston & Albany Railroad, in order to avoid raising the trolley wires above the gate, an automatic device will be employed in connection with the gates to prevent interfering with the trolley wires. Twenty cars are to be equipped out of those now running on the road, three being fitted up at a time. The work on these has been already commenced. All the latest devices for the complete equipment of the cars will be employed, and the Thomson-Houston Company expect to have them running to accommodate the public by the first of February. In regard to the power station, it is proposed at present to utilize the works of the Cambridge Electric Light Company, and place therein five h. p. generators and complete switch-board for operating the same. The steam plant is already being placed in the station, and the work of setting up the generators has been begun. When the road is equipped with the present order, which has been received from the West End Railway Company, 20 cars will be running from Bowdoin square to Arlington, each of which cars will have sufficient power to run a tow car. All cars will be lighted with electric lights and equipped with a headlight.

W. I. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 South Tenth Street, Philadelphia, Pa., Jan. 12, 1889.

The Eighth Street Electric Light Company, of Philadelphia, was chartered by the State Department this week, with a capital stock of $10,000.

Pittsburgh, Pa.—The Pittsburgh, Allegheny & Manchester Street Railroad, of Pittsburgh, has been sold to a syndicate, which is seriously considering the advisability of adopting electricity as a motive power.

The Partz Electric Battery Company, of this city, report a good business. They are now manufacturing a smaller-sized battery than heretofore, and expect to be able to compete with some of the older batteries in the matter of convenient size, while they claim greater efficiency.

Camden, N. J.—A number of Camden, N. J., capitalists are favorably considering a project to lay an electric railway along the principal streets of the city. So far no articles of incorporation have been filed, but it is understood that the project only awaits another meeting of the leaders to become operative. The road will be laid, it is stated, along Market and Federal streets, north and south, and will connect with Cramer's Hill.

Reading, Pa.—A dispatch from Reading says: "The petition of the Consumers' Gas Company was presented to Court, asking for an injunction to restrain the city and the Reading Electric Light Company from carrying out the provisions of the contract entered into by them for lighting the streets for the ensuing year. The Consumers' Gas Company claim to have been the lowest responsible bidder, and allege that as no appropriation has been made for lighting the city, the contract with the electric company is void. A preliminary injunction was granted."

The Electric Light as a means of public illumination is having quite a boom in southern and western New Jersey, as the following notes will show. The Beverly Electric Light and Power Company have filed articles of incorporation in Mount Holly, with a capital of $50,000. The Salem City Council has voted to have the streets lighted by electricity. The authorities of Egg Harbor City have granted an exclusive franchise for fifty years to an electric light company, and have agreed to contract for 150 arc lights for the streets of that place. The West Jersey Electric Light and Power and Heat Company, which will supply Merchantville with lights, was incorporated in Camden last week. The Washington (Penn.) Electric Light and Power Company has been incorporated with a capital of $5,000.

E. W. E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Jan. 12, 1889.

Personal.—Mr. F. S. Terry, of the Electrical Supply Company, is in the East this week.

The Van Depoele Company.—The Van Depoele Electric Manufacturing Company sold last week to the Monroe Electric Light and Power Company, of Monroe, La., a plant of 60 arc lights, also a small plant to the Allen Manufacturing Company, of Chicago.

Cincinnati, O.—At a meeting of the Brush Electric Light Company of Cincinnati, the following officers were elected; Louis Seasongood, president; Leopold Markbreit, vice-president; H. E. Cooke, secretary, superintendent and general manager; H. Ryland, treasurer.

A New Time Corporation.—The Hyde Park Standard Time District Telegraph Electric Company, of Hyde Park, Ill., has received incorporation license from the Secretary of State. The company purpose to do a general electric business, their capital stock being $25,000. The incorporators are Lewis Degan, H. G. Smiley and R. L. Terry.

Joliet, Ill.—The Secretary of State has granted the Joliet (Ill.) Light, Power and Transit Company an incorporation license to build and operate cable, horse or dummy railways in the city of Joliet, and for the manufacture of gas and electric light and power; capital stock, $300,000; incorporators, Lewis E. Ingalls, John R. Staley and Jason L. Watson.

An Electric Railway at Elkhart.—A special from Elkhart Ind. of Jan. 7 states "that a number of the leading capitalists of that city to-day organized a company to furnish electric power for the street railway, stationary power, arc and incandescent light and heat. The company will also establish the manufacture of electrical machinery and appliances."

Bentley-Knight Branch Office.—The Bentley-Knight Electric Railway Company, of New York, have just opened a new branch office at 603 Pullman building, under the management of Mr. J. Gorham, who will have on exhibition a full line of the equipment of his company, including motors, trolleys, conduits, rawhide gears, overhead wire, supporting posts, etc.

The New Electric Railway at Cincinnati.—I learn through the Western department of the Sprague Company, that work on the new electric railway at Cincinnati, which is being built for the Inclined Railway of that city, has been begun. The road will be equipped with twenty cars to start with, the "Boston" motor being used, with separate trucks. This design of car will enable the cars to be run in winter as closed and open in summer.

The Convention.—Applications for floor space to be used by the exhibitors at the coming convention are being received by Mr. B. E. Sunny, chairman of the executive committee, and everything points towards a very interesting and valuable meeting. As soon as the applications are all in or nearly so, the spaces will be allotted. Charges for space will be only a nominal amount and will be governed by the cost of power, janitor service, etc. Applications for space should be addressed to Mr. Sunny, at 148 Michigan aveue.

The New Telephone Ordinance.—The Telephone Ordinance, of which you have already given details, came up at the meeting of the council Friday night as a special order. A heated discussion preceded the ballot, the ordinance finally being passed by a vote of 27 to 18. The old Bell Telephone ordinance was repealed by unanimous vote. The new ordinance, as passed, provides that in a given district the company shall place two miles of wire, annually, in underground conduits. The duration of the ordinance is twenty years.

Underground Wires in Milwaukee, Wis.—A special from Milwaukee, Wis., dated Jan. 4, states that the Council discussed that day the ordinance requiring all telegraph and telephone wires to go underground. There were present at the meeting F. H. Tubbs, Western Superintendent of the Western Union; C. H. Sommers, the company's general electrician, and J. S. Robinson, the company's superintendent of repairs in Chicago, each of them testifying that the company's underground system in Chicago was a failure, and that as yet there was no perfect system. It was decided to examine the Chicago system before making a report.

Quick Work in Wiring.—Mention was made in these columns a short time ago of the wiring of the Chicago Opera-House, which had been damaged by fire. Mr. F. A. Sargent, superintendent of the Chicago Edison Company, had the matter in charge, and the 400 lights were wired in less than three days. It was required in order to get the work completed on time to employ between fifty and sixty experienced wiremen. This perhaps illustrates as well as anything can the advance of the art of electrical construction work. To have performed this amount of work in the short time stated would have been impossible a few years ago without the trained electrical artisans we have to-day.

A New Copper Manufacturing Plant has, I learn, been established at Dollar Bay, Michigan, by the Tamarack-Osceola Manufacturing Company. The plant consists of a smelting works, rolling mills and wire drawing mills of the most approved modern construction. The company are now ready to manufacture copper wire for electrical purposes, which will be one of their leading specialties. The company also manufacture bolt and sheet copper. They have their own wharf at which the largest lake steamers can moor for the transportation of copper and supplies of coal, etc. They are also well provided with railway sidings. These works, which mark a notable new departure in copper manufacture, are under the management of Mr. R. G. Collins, general superintendent.

Regulating Telephone Charges.—A special from Jefferson City, Mo., Jan. 4, states that Senator Castleman, of St. Louis, will introduce a bill to regulate telephone charges, in the State Senate, of which the following is the text: Section 1. The annual charge for the use of a telephone in all cities in Missouri having 100,000 inhabitants or more shall not exceed $50; and in all cities, towns and villages in Missouri having less than 100,000 inhabitants the annual charge for the use of a telephone shall not exceed $36. Sec. 2. Any corporation, president, agent or officer thereof, and any person who shall charge, collect for the use of a telephone any sum in excess of the rates fixed by this law shall be deemed guilty of a misdemeanor, and on conviction shall be punished as prescribed in Section 1,663 of the General Statutes, and every such case shall constitute a separate offense.

Electric Light Trust for St. Louis.—A special of Jan. 7 from St. Louis, says that the four electric light companies doing business in that city have just discovered that competition does not pay so well as consolidation. A combination has been formed whereby competition will be killed and prices restored. The companies in the deal are the Thomson-Houston, the Brush, the Metropolitan Electric Light, and the Western Electric Light Association. The prices have been so low during the last year that the companies assert they have not made a cent. The Thomson-Houston company proposed a trust and the other companies accepted the idea. It is given out that the Thomson-Houston company has purchased the controlling interest in the other four companies, but from other sources it is learned that the stock of the other companies is merely held in trust.

The New City Plant.—The *Tribune*, of Dec. 24, says editorially, with reference to the city electric light plant: To-night Prof. Barrett will officially start up his 183 electric street lights, and downtown shoppers Christmas Eve will see the streets almost as bright as day—brighter than some days when the steam boiler stokers get in their work. When the people come to see the change that is wrought they will insist that the system shall be extended as speedily as possible to all other parts of the city, and it is probable that before many years Chicago will be the best lighted great city in the world. We have been slow here in shaking off the thralldom of gas, which has become an antiquated illuminant, and might have been slower still but for the rapacity of the Gas Trust; but it is doubtful if much has been lost by the delay. We have been saved from experimenting, and from many possible false starts. There will be nothing to change, no money wasted. It is a good thing for municipalities and individuals to "go slow" occasionally.

The Heisler Electric Light Company has been awarded a contract for the lighting of the American Part of the Paris Exhibition. The whole plant will be completed and tested before shipping at the St. Louis Illuminating Company's station, when the local technical societies of St. Louis will be invited to see it. It will consists of a dynamo of 1,000 incandescent light capacity, showing the utility of a two independent circuit system, each room or locality wired from both circuits. Lamps will be exhibited from 10 up to 300 c. p.; the automatic regulation will be arranged so as to indicate the reduction of power when lights are turned off; 10 miles of circuit wire No. 8 will be inserted, so as to indicate the practicability of carrying the current to any desired distance; a registering current meter will be included in the exhibit; 24 clusters of incandescents will be suspended from the ceiling, of various candle power, posts being provided with side brackets such as used for indoor work, but in addition 50 street lamp brackets will be fastened to posts to indicate a system of street lighting as used in a number of our American cities.

Doings in the City Council.—At the meeting of the City Council last Monday evening the State Street "L" road ordinance received another set back. The Judiciary Committee recommended that the proposed ordinance be placed on file, and the motion was accordingly adopted. A motion was made to reconsider the recent telephone ordinance passed by the Council, but the motion was decided out of order by the Mayor, who stated that the ordinance had received his signature. The following, however, was introduced and unanimously adopted: Ordered, that the City Law Department be, and it is hereby directed to immediately draft an amendment to the city charter authorizing the City Council to regulate the telephone rates, also to license telephone companies; said amendments shall be submitted for passage to the State Legislature. Orders were also introduced for an estimate for the lighting of Milwaukee avenue from North avenue to Desplaines street by electric light; also for Archer avenue, Blue Island avenue, and Goose Island. The Mayor informed the various gentlemen who introduced these orders that Professor Barrett was preparing estimates for all the thoroughfares named, and for others in various parts of the city, and that the report would be submitted to the Council at an early day.

A Huge Joke.—A certain morning paper published in this city has for some time past felt it its bounden duty to attack nearly every social and political institution, whether good, bad or indifferent. In its opinion political parties were not good enough, certain officers of the law were thieves and black-legs, our workshops were slave houses, the honored profession of medicine was being prostituted, and gambling and every species of vice were running riot. Apparently the scheme was a death struggle with the paper to gain subscribers by sensational reports. In consequence of these reports many innocent

people have been made to suffer great injustice, and as a result several libel suits have been brought against the editors of the sheet. Among the "sufferers" I may mention the Electric Club, which was charged with running a gambling den of the vilest sort, having a full equipment of tables, faro bank, etc., and employing regular bunco steerers to rope in the innocent from the hotels, etc. A madder piece of fabrication was never invented and in its subsequent issue the paper made due retraction and stated that it was misinformed. This, of course, amended the matter somewhat, but in electrical circles it has for the past few days been the chief topic of indignant conversation, and is now regarded as the the greatest joke of the season.

A Christmas Decoration.—A correspondent writes me from Red Wing, Minn., and encloses a description of a Christmas decoration made by the writer for the First M. E. Church of that city as follows: The church was beautifully decorated with flowers and evergreens, suspended from chandeliers, and hung in festoons about he windows and the beautiful pipe organ. Across the front of the organ was arranged a large motto "Peace on Earth" with 12 16-c. p. lights, one in each letter, and so arranged that the wires were movable. I then arranged a large star three and one-half feet from point to point, and decorated it with evergreens. On each point was fixed one 16 c. p., incandescent lamp and one in the centre, making 6 incandescent lamps on the star. I had the rest of the light fixtures wired for 27 16-c. p. lamps. When the services began, the church was crowded, even the aisles being filled, and on the opening of the exercises all the lights were turned out in the church (the motto and star lights had not been lighted yet, as that was to be the crowning glory of the evening). Only three lights burned for the organist. Then four little girls stepped out on the platform, and sang "There is a Star in the Sky," and just as they turned half way around, and pointed to the star and spoke the word, the lights from the star and motto flashed forth their brilliancy. The effect was very fine. After the song the other lights (27) were turned on. The exercises were interesting, and the public were high in their praises of the grand treat.

Electricity in San Diego, Cal.—A correspondent writing from San Diego sends me some notes of the electrical situation there. The San Diego Telephone Company, of which Mr. W. J. Thompson is manager, has 284 instruments in use. The telephone wire along the National City & Otay railroad system is used exclusively as the railroad wire—which is believed to be the first instance where the telephone has superseded the telegraph for railroad purposes. An average of forty passenger trains per day run over the sixty miles of track of the National City and Otay system, yet the telephone service has been so perfect that an accident or misunderstanding has never occurred. In electric lighting San Diego is well abreast of the times. The local Indianapolis Jenney Company, run by E. S. Babcock, Jr., and L. M. Vance, have a five years' city contract. Their plant comprises seven 30-light arc Jenney machines, a 30-light Western Electric arc machine, and a 100-light Jenney incandescent for series work. They will soon be operating about 300 of these series incandescent lights. The Electric Rapid Transit Company have put in a Westinghouse alternating plant comprising two 650-lighters. The full capacity has been sold. There is also a large Edison plant—600 lights—in the Pierce-Morse building, and a Mather plant of 2,100 lights capacity in the Hotel del Coronado, under charge of Mr. F. V. Pinkham. The Transit Company above referred to is using the Henry electric railway system with a plant consisting of 4 shunt wound Henry generators in series, with a working current of 100 ampères and 260 volts; a 100 h. p. Hazelton boiler and a 125 h. p. Buckeye engine. About 4 miles of electric road are operated, part overhead and part conduit. The motors on the road develop about 25 h. p. each. A speed of 8 miles an hour is obtained, but on an extension now being made 15 miles will be the speed. The president of the company is Mr. G. D. Copeland. E. L. P.

MILWAUKEE, Wis., Jan. 5, 1889.

Manitowoc, Wis., will introduce electricity for street lighting.

Green Bay, Wis.—The Green Bay & Fort Howard Electric Street Railway Company has filed its bonds, which insures beyond doubt the establishment of a street car line next spring.

Waupaca, Wis.—On Tuesday night last the Waupaca Electric Light Company had everything in order at the new water-power plant, which was so unceremoniously swept away by the washout in September, and celebrated the New Year by having the city more brilliantly illuminated than ever with the Brush electric light. Everything is in good shape again, and Waupaca is the best lighted little city in the State. The company is composed of home men. W. M. G.

KANSAS CITY, Mo., Jan. 5, 1889.

The Telephone.—The days of the telephone company are full of trouble and its nights are full of grief. In the day time behold the subscriber kicketh, and at night, lo, the sleet smiteth the wires and the poles thereof, and the line falleth down.

The sleet storm of the holidays that fell upon this city almost completely wrecked the telephone system. Of the 2,500 telephones in the city not over half had connection with "central." The company, moreover, has had trouble from the attempt to equalize business and residence rates, and because of the bills now before the State Legislature to reduce telephone charges. K. C. M.

THE TELEGRAPH.

The Mexican Telegraph Company is laying a new cable across the Gulf of Mexico.

The Nantucket Cable has once more been repaired, by Lieut. Wright, of the Signal Service.

Pensacola, Fla.—The city has awarded a contract to the Gamewell Fire Alarm Telegraph Company for a fire-alarm system to cost $3,140.

A Splendid Calendar, full of electrical dates, has just been issued by the Direct United States Cable Company, Limited, of which Mr. James Brown is the superintendent. It is a large and handsome lithographic card, with cord loop, and besides showing the cables crossing the Atlantic gives neat little vignette views of Valentia, Ballinskelligs, Halifax, N. S., New York and Boston. At the top, supported by the eagle and the lion, is the Statue of Liberty.

THE TELEPHONE.

"Too Late, Too Late!"—A special dispatch from Des Moines, Ia., of Jan. 7 says: Mr. M. F. Pease of this city claims to be the original inventor of the telephone, and produces evidence of a very convincing character to substantiate his claim, which will be investigated in the Patent Office. Mr. Pease began experimenting with the transmission of sound by electricity in 1855, and in 1857 his efforts were crowned with success. That year he filed a caveat in the Patent Office at Washington, giving a description of his machine under the name of the "electric musical instrument." Later he perfected a telephone, and in 1872 his invention was described in a book entitled, "Wonders of Electricity."

Telephone Rates.—The new bill introduced at Albany to fix telephone rates in this State, provides that the subscription in cities of 500,000 inhabitants and over shall not exceed $6 per month, and in all other places $3 per month.

THE ELECTRIC LIGHT.

Winchester, Va., is still talking about electric lights.

Birmingham, Ala.—Mr. A. W. Fuller is organizing an electric light company.

Taylor, Tex.—Negotiations are progressing for a Western Electric plant to cost $25,000.

Goodrich, Tenn.—The Warner Iron Company propose to buy an electric light plant at once.

Lockport, N. Y., is agitating the electric light question, and talks of having a plant of its own.

Lynchburg, Va.—The Piedmont Electric Illuminating Company proposes an increase of capacity.

Augusta, Ga.—The Sibley Manufacturing Company have put an incandescent plant in their big cotton mill.

Perth Amboy, N. J., is still waiting for its electric lights, and will not be happy until Messrs. Seabury & Johnson get their plant running.

Savannah, Ga.—The Savannah Electrical Company has been formed by H. Myers, J. J. McDonough, D. Garrard and others, with a capital stock of $50,000, to establish a burglar alarm service, etc.

The Johnstone Underground System, which was illustrated in THE ELECTRICAL WORLD of Jan. 12, has just been put in use in Harlem for arc light service with the Fort Wayne Jenney system.

Selma, Ala.—The city of Selma is in a fix because it cannot get any more light until it has paid the Selma Gas and Electric Light Company for the ten months' illumination it has had already and guarantees its bills for the future.

Terre Haute, Ind.—The city has made a new contract for street lighting with the Terre Haute Electric Light Company, of that city, using the Thomson-Houston system. The contract calls for all the lights that may be required, of 2,000 c. p., for 2,500 hours yearly, at the rate of $70 per light per annum.

Red Wing, Minn.—The Red Wing Gas and Electric Light Company are putting in a 750-light Westinghouse alternating dynamo to replace a number of smaller incandescent dynamos. The poles are all up, and the wire has just arrived. They will use about two tons of No. 1 underwriters' wire for the primary.

Portsmouth, Va., has an Edison Electric Light and Power Company, which has organized with Mr. H. L. Maynard as president and Mr. J. L. Watson as secretary and treasurer. The plant is to start with a capacity of from 1,000 to 1,500 lights. The capital stock is to be not less than $25,000 and will not exceed $150,000.

Seattle, W. T.—The Seattle Gas and Electric Company are now operating 100 arcs, and will, it is believed, soon reach 300 or 400, as the city is growing rapidly. The monthly rate since October has been $14.50 to $16.50. One of the local mills has added a Waterhouse 35-lighter, and operates now 70 arcs. Another has purchased a Ball 25-lighter.

North Manchester, Ind.—The Jenney Electric Company of North Manchester, Ind., have been awarded the contract for lighting the town with 14 arcs and 2 series incandescents, for a term of five years. They use the Indianapolis Jenney system, and will put in a 30-light dynamo, 60 h. p. engine, erect new buildings and have a model station. Mr. G. Burdge represents the company.

Berlin, N. H.—The local *Independent* says: "The incandescent electric lights which have come into such general use in business places in Berlin are proving a big success. They were put in by the Sawyer-Man Company, by their agent, Mr. Cary. The *Independent* office is supplied with them, and well do they perform their duty. We can cheerfully recommend this company and Mr. Cary to all who contemplate electric lighting their homes."

St. Louis, Mo.—It is stated that the Thomson-Houston Company in St. Louis has acquired practical control of the local Brush Electric Association, Metropolitan Electric Light Company and Western Electric Association. Rates have been cut for some time past, and the consolidation will result, it is said, in a return to normal prices. The Thomson-Houston Company has elected P. P. Manion, C. C. Carroll, J. N. Bofinger, W. H. Beach and D. R. Powell, directors.

The Light for Pearl Fishing.—At the request of the Board of Revenue Dr. Thurston, the superintendent of the Madras Museum, is visiting the several electrical establishments in Europe, with a view to select for use at the various pearl fisheries in India an electric globe light that would operate in 20 fathoms of water. The want of such an appliance has long been felt, and the work at the pearl fisheries at present has to be confined to pearl banks situated in less than twenty fathoms of water.

The Mt. Morris Company.—The Hill Clutch Works have closed a contract with the Mt. Morris Electric Light Company, of this city, for the complete equipment of their large new station on Greenwich street, with everything in the line of power transmission machinery and friction clutches. This plant will have a capacity of 1,500 horse-power, and when complete will be one of the finest in the country. The Mt. Morris Company are to be congratulated on closing this important contract with the Hill Clutch Works, whose extended experience in laying out and equipping electric light stations, and their well-known reputation for good work, insures a plant which will be second to none.

Engines for Electric Light Plants.—Among the recent sales and installations of "Beck" automatic engines and complete steam plants, the Taylor Manufacturing Company, of Chambersburg, Pa., report the following: three 13½ by 15 in. Beck engines and two 66 in. by 16 ft. steel boilers to the Lancaster Arc Light Company, Lancaster, Pa.; 12½ by 15 in. "Beck" engine and 72 in. by 16 ft. steel boiler to the Carlisle Gas and Water Company, Carlisle, Pa.; 11½ by 15 in. "Beck" engine to H. P. Gregory & Co., San Francisco, Cal.; 15 by 18 in. engine to the Cummer Electric Light Company, Cadillac, Mich.; 12½ by 15 in. engine to W. B. Myers, Carthage (Mo.) Electric Light and Power Company, together with 60 in. by 16 ft. boiler; 11½ by 15 in. engine for the Schuyler Electric Light and Power Company, Marion, Ohio; 13 by 15 in. engine for the Northampton (Mass.) Electric Light Company; 7 by 8 in. engine to Grace Hospital, Detroit, Mich.; 7 by 8 in. engine for the Jos. Horne building, Pittsburgh, Pa.; 9½ by 12 in. engine for Gore's Hotel, Chicago, Ill.; 9½ by 12 in. engine to Leonard & Izard, for Wauwatosa, Wis. 11½ by 15 in. engine to Comey & Johnson, Cleveland, Ohio; 15 by 18 in. engine to C. C. Mengel & Bro., Louisville, Ky.; 16 by 24 in. engine to Glendron Iron Wheel Company, Toledo, Ohio. Also, through Cooke & Co., one 10½ by 12 in. engine; one 8¼ by 10 in. engine for Williamsburgh, N. Y., and a 11½ by 15 in. engine for the *Judge* building, New York city.

APPLICATIONS OF POWER.

Memphis, Tenn., is soon to have an electric road. Mr. H. Cummins and others interested will place the contract with the Sprague Company.

Chattanooga, Tenn.—The Chattanooga & Highland Park Electric Street Railroad Company have bought the control of the Mission Ridge Incline Railway, and will run that also by electricity.

Detroit, Mich.—The city authorities of Detroit are considering electric railways, and propose a tour of inspection. Mr. Fred H. Whipple offers to save their time, however, and to give them all the information they want for $450.

Southington, Conn.—The Thomson-Houston Company has closed a contract for the equipment of two miles of single track at Southington, Conn. The overhead line is all completed except the curves, which are now being put in. The bracket method of suspension is used except on the curves, where the cross suspension is employed. Each of the cars will be equipped with two 10 h. p. Thomson motors.

Eickemeyer's Electric Motors.—J. H. Bunnell & Co. find a brisk demand for the Eickemeyer motors. The *Morning Review*, published at Spokane Falls, Washington Territory, says: "The motive power for the *Review* is furnished by a 3 h. p. Eickemeyer electric motor. This little machine is encased in a cast-iron box about fourteen inches square, and with belt pulley does not occupy a space larger than an ordinary grip sack. The boiler and engine formerly in use has been relegated to 'innocuous desuetude.' The *Review* will now be run off with lightning speed, necessary to keep up with the times and the large increase in circulation.'

PERSONALS.

Prof. A. G. Bell is to lecture this week at Cornell. The students are to be envied.

Mr. P. C. Burns has severed his connection with the St. Louis Battery Manufacturing Company, of St. Louis, Mo.

Mr. W. F. D. Crane, lately associated with the Baxter Company, in Baltimore, has become the electrician of the Wenstrom Southern Electric Company, of the same city.

Mr. Horace Van Sands, formerly of this city, is to represent in Chicago the Brooklyn bell manufacturing house of H. E. & C. Baxter. His headquarters are at 36 La Salle street.

Mr. Chas. P. Bruch has resigned the secretaryship of the T. M. B. A. to accept a similar position with the Non-Magnetic Watch Company. Mr. T. E. Fleming has been appointed to succeed him.

Mr. Frank Ridlon was one of the leading figures at the recent opening of the Brush station installed by the local authorities of Danvers, Mass., for city lighting, and made a very neat and forcible address on the importance and significance of the new departure.

Mr. Cuyler C. Smith, the wire chief of the Western Union Company at Buffalo, N. Y., read a paper on Jan. 8 before the local Electrical Society on methods of electrical measurement, especially as applied by telegraphists to the determination of breaks, grounds, etc.

Mr. Alfred F. Moore, the well-known manufacturer of insulated wire, has issued a fine, bold calendar. On each monthly sheet the individual figures are nearly two inches long. At the bottom of the card are all the months condensed, for easy reference.

Prof. C. R. Cross delivered an interesting address on Jan. 10 before the Boston Society of Arts on the recent studies pursued by the department of physics of the Massachusetts Institute of Technology in telephony.

Mr. E. T. Gilliland has been elected vice-president of the Empire City Electric Company, and thus becomes associated in that active, growing concern with another well-known old telephonist and not less successful business man, Mr. O. E. Madden who is the president of the company.

Prof. H. A. Rowland, of Johns Hopkins University, is known to his friends as an enthusiastic photographer, to whom the application of the word "amateur" seems sadly out of place, so beautiful, finished and perfect is his work. The last number of *Harper's Magazine* contains some splendid productions of his camera.

Mr. J. W. Godfrey, the well-known general manager of the New York Insulated Wire Company, has, we regret to learn, suffered a sore loss in the death of his only son, a youth of great promise. To one whose sympathies with others in grief or trouble are always so ready and hearty, the condolence of hosts of friends will be warmly extended.

Mr. Jay Gould has sustained a heavy blow in the death of his wife this week from the effects of a shock of paralysis. Mrs. Gould was a woman of charitable instincts and broad sympathies, but her home was the centre of her thoughts and affections, and in her domestic life were exerted to their fullest degree her great charms of mind and disposition.

Mr. G. Moulton, of Bridgeport, Conn., has built a novel toy. It is an iron boy, 4 feet 8 inches high, who drives a hand cart. Inside the boy and propelling him is an electric motor, the current for which is derived from small storage batteries in the cart. Mr. Moulton believes that his boy could walk from Bridgeport to New York in eleven hours.

Mr. H. C. Adams, who was with the well-known metal and wire house of Holmes, Booth & Haydens for over 20 years, and recently Secretary, Treasurer and, finally, President of the American Electric Manufacturing Company, has taken charge of the New York office of the Fort Wayne Jenney Electric Light Company, just opened at 115 Broadway.

Mr. Walter T. Wonham, who represents the Hill Clutch Works in this city, is to be congratulated on the success that has so remarkably attended his efforts in this territory. The concern have now been awarded the contract for the 1500 h. p. station of the Mt. Morris Company, which promises to be one of the finest pieces of engineering in the city. The execution of the undertaking is certainly in good hands.

Mr. John I. Beggs has been presented by the employés of the first district of the New York Edison Company with a beautifully engrossed expression of their good will to him for the interest he has shown in their behalf and his endeavor to close the "chasm between capital and labor." If there were more of this reciprocal spirit there would not be much chasm left. Mr. Beggs has the resolutions hanging handsomely framed in his office on Fifth avenue.

MISCELLANEOUS NOTES.

The Patent Office has received special attention the past week from the New York *World*, which has ventilated the subject pretty extensively by calling attention to certain abuses and defects.

A New Electro-Technical Society.—A new electro-technical society, called the "Centro Technico dos Electricistas Brazileiros," has just been founded at Rio de Janeiro. The temporary address of this society is Arsenal de Marine, Rio de Janeiro.

Trying It On Snakes.—A report comes by way of Germany that a novel use of electricity has been made in India for the prevention of the intrusion of snakes into dwellings. Before all the doors and around the house two wires are laid, connected with an induction apparatus. Should a snake attempt to crawl over the wires he receives a shock of electricity which either kills or frightens him into a hasty retreat.

An Anniversary Number of great beauty and excellence has been issued by the well-known insurance paper, *The Spectator*, to celebrate its twenty-first year. It is full of good reading, historical and reminiscent, as well as practical and timely. One of the most interesting pieces is that on John Wanamaker—who, by the way, has electric light interests of no small amount—on his life insurrance of $1,250,000. The article is from the facile pen of "Joe Howard."

The Magnetic Club —The annual meeting of the Magnetic Club was held on Jan. 10, when the following election of officers was made: E. F. Howell, as one of the vice-presidents, in place of Gardner Irving, who resigned, and A. Beatie as a member of the Governing Committee, in place of E. F. Howell. The full list of officers is Charles P. Bruch, President; Wm. J. Dealy, E. F. Howell, Wm. L. Ives, Lant S. Jones, Vice-Presidents; Geo. F. Fagan, Secretary; John Brant, Treasurer; J. B. Taltavall, D. W. McAneeny, J. M. Moffatt, W. H. Baker, A. Beatie, T. F. Cummings, Conrad Meyer, T. A. Brooks, Governing Committee. An amendment was proposed to the third article of the constitution, which limits the membership to 100, proposing to increase the membership to 150, but this was negatived.

BUSINESS NOTICES.

Messrs. James Leffel & Co., Springfield, O., have made a number of improvements in their well-known "Old Reliable" water wheel, and, as now manufactured, offer it as the cheapest and best wheel in the market.

The Ætna Machine Company, of Warren, O., have closed a contract with the Chicago Splice Bar Mills, owned by Morris Sellers & Co., of Chicago, Ill., for a 500 h. p. engine to drive a train of rolls. The Ætna Company have lately been in receipt of a number of such orders for large engines.

The New York Belting and Packing Company, New York, have just issued a new pocket catalogue of their well-known vulcanized rubber specialties, which will be cheerfully furnished to those making application for it. It is very neat and handsomely gotten up, with illuminated cover printed in six colors.

The Lidgerwood Manufacturing Company, New York, have just issued their new catalogue for 1889. It is a beauty, and a credit to this enterprising concern. The book contains fully a hundred excellently executed engravings of their superior hoisting machinery, boilers, etc., and will be forwarded to those making application.

Patterson, Jordan & Gottfried, 146-150 Centre street, carry a complete stock of brass and iron machine and wood screws, cap and set screws, all kinds of bolts, taps, files, twist drills, brass and rubber tubing, brush copper, rod and sheet copper, brass rod, sheet German silver, sheet brass, machinery, tools, hardware, etc., and electrical supplies.

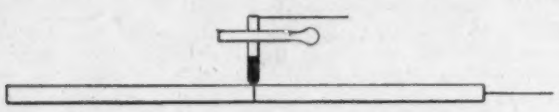
Springfield, Mass.—The Hill Clutch Works have closed a contract with the United Electric Light Co., of Springfield, Mass., for the equipment of their new station. This plant, which will be about 900 horse-power in capacity, was designed by the Hill Clutch Works, and will be fitted up complete with their clutch pulleys and clutch couplings and power transmission machinery. The Hill Clutch Works hope to make this plant in point of fine machinery and workmanship a fair rival to their large plants in St. Paul and Minneapolis, Minn., which are reputed to be by far the finest and most economical running plants in the West.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS DATED JANUARY 8, 1889.

395,682. Electric Train Brake Apparatus; A. I. Ambler, Washington, D. C., Assignor to R. N. Ambler, of same place. Application filed April 18, 1888. In constructing and applying train brake apparatus there is employed a reversable electro-motor, a screw or worm shaft, a transverse nut moving thereon, elastic cushions on each end of the shaft, a central lever of appropriate construction, frictional pulleys and a flexible connection between the long arms of the truck levers. Also, suitable storage batteries to energize the motor, and a switch-board both on the locomotive and on each of the cars. By this apparatus the brakes may be operated and set at each end in case the train breaks in two.

395,703. Trolley for Electric Railways; W. F. Jenkins, Richmond, Va. Application filed April 18, 1888. The flanges of the trolley are circumferentially scalloped, so that when the trolley which bears against the under side of the cable passes a branch



395,878. PROCESS OF ELECTRIC WELDING.

cable, the branch will be received in one of the scallops of the flange and the trolley is allowed to proceed on the main line cable without lifting the main line from its connection with the trolley as it passes the branch.

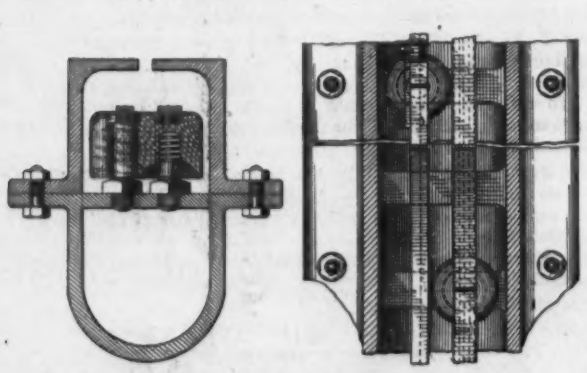
395,706. Dry Voltaic Battery; Isidor Kitsee, Cincinnati, O. Application filed April 19, 1888. A battery compound for a dry voltaic cell, consisting of chloride of ammonia, bi-sulphate of mercury and chlorine.

395,755. Holder for Electric Arc Lamps; J. Pawlowski, Cincinnati, O., Assignor of one-half to Andrew Winter, of West Covington, Ky. Application filed Sept. 15, 1888. The object is to provide a hanger for arc lamps which, should any lamp of the series be dislodged from its position by storm or any accident, will of itself instantly close the circuit and prevent the other lamps of the series from being affected.

395,761. Conduit for Electric Railways; Samuel Trott, Halifax, Nova Scotia. Application filed Jan. 27, 1888. At intervals along the bottom of the conduit are mounted on vertical pins, glass or porcelain insulators similar in construction to the ordinary telegraph pole insulator. These alternate with each other in two rows, and the conductors are supported in grooves formed in their tops. The conductor is wedge shaped in cross-section and locked into the groove in the upper ends of the insulators by means of a wedge shaped key. See illustration.

395,769. Voltaic Battery; T. Coad, Forest Gate, England. Application filed Aug. 6, 1888. The cells are placed in a box which is divided into compartments by partitions. One of the elements, such as the zinc, carries a lateral extension which passes through the partition and into contact with the element in the adjacent cell of opposite character. This contact is maintained by a wedge or key.

395,773. Cathode for an Electro-Depositing Apparatus; E. Emerson, Providence, R. I. Application filed March 19, 1888. The object of this invention is to produce bars of



395,761. CONDUIT FOR ELECTRIC RAILWAYS.

copper by electro deposition of a length and quality that will render them marketable without further treatment. The cathode consists of a strip of sheet metal spirally wound upon a cylinder of insulating material, such as wood. A space is left between each turn of the strip. After the deposit has been built up to the desired thickness, it is stripped from the cathode by taking hold of one end and peeling it off. See illustration.

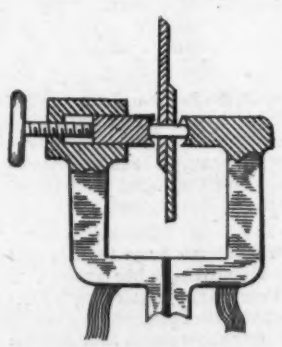
395,783. 395,781. Art of Compiling Statistics; Herman Hollerith, New York, N. Y. Applications filed Sept. 23, 1884, and June 8, 1887, respectively. Briefly stated, the method and apparatus comprise, first, a strip or web of paper or other material carrying circuit actuating index points, the latter representing by their relative location the arrangements and various statistical items pertaining to the individual or thing, the records of a number of individuals being located or arranged successively upon said strip or web; second, a templet or index for properly indicating the several index points to form the record of each individual; third, a revolving drum and a series of circuit breaking and closing points, the record strip being passed between said points and drum in a manner to cause the index points to actuate the circuit controlling devices; fourth, a series of electric circuits connected to, and controlled by, the circuit breaking and closing points, and fifth, a series of mechanical registering devices actuated by electro-magnets included in circuits controlled by the circuit making and breaking points.

(1) 395,837. (2) 395,835 and (3) 395,836. (1) and (2) Methods of Preparing Solution Compounds for Galvanic Batteries; (3) Apparatus for Charging and Discharging Secondary Batteries; William P. Kookogey, Brooklyn, N. Y., Assignor to the Kookogey Electric Company. Applications filed Aug. 13, June 11, and June 11, 1888, respectively. (1) and (2). Two processes of making a battery compound whose ingredients are sulphate of soda, bichromate of soda, and sulphuric acid, the first consisting in dissolving the bichromate in just enough hot water to hold it in supersaturated solution, and then mixing therewith the sulphuric acid and sulphate of soda; second dissolving the sulphate and bichromate in about one-half of the quantity of acid to be used, the same being heated and then adding quickly the remainder of the acid. (3) The storage battery is alternately connected in the charging circuit and the working circuit by means of a series of circuit closers operated by an electro-magnet in the working circuit.

395,878. Process of Electric Welding; Charles L. Coffin, Detroit, Mich. Application filed Sept. 18, 1888. This is a soldering process, in which one of the terminals of the circuit is a piece of solder, the other terminal being more refractory metal. The heat of the arc fuses the solder and deposits the molten metal on the joint of the two articles to be welded together. See illustration.

395,932. Medical Battery; Henry E. Waite, New York, N. Y. Application filed Aug. 15, 1888. This is a cabinet embodying a complete electrical apparatus for the treatment of disease. The appliances are arranged in a convenient and accessible manner, so that the practitioner may make use of the current in various ways, and can also apply various kinds of current without delay or hindrance.

395,936. Regulator for Incandescent Electric Lighting System; Merle J. Wightman, Hartford, Conn. Application filed June 29, 1886. This invention consists in a regulator which automatically puts into circuit compensating resistances or



396,015. METHOD OF ELECTRIC RIVETING.

safety lamps whenever one or more of the lamps in the external circuit is in any way removed therefrom.

395,950. Electrical Heating; John V. Capek, Brooklyn, N. Y., Assignor to himself and Edward H. Johnson, of New York, N. Y. Application filed March 12, 1888. This invention contemplates making a heating apparatus of the wainscoting of a room. It consists in coating sheets or plates of refractory material with a carbonaceous material. An electric current is passed through the coating, which is so regulated that the heat generated will not be sufficient to ignite surrounding combustible material. See illustration.

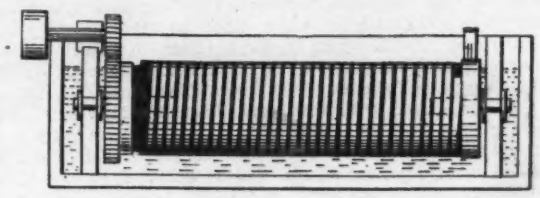
395,959. 395,958. Electric Signaling Apparatus; Mark W. Dewey, Syracuse, N. Y., Assignor of two-thirds to E. Laass and C. H. Duell, of same place. Applications filed April 13, 1888 and March 31, 1888, respectively. (1) The object of this invention is to enable a public fire-alarm box to be operated and controlled at a distance, and thus economize in time in sending in an alarm. To this end the invention consists essentially in employing in the alarm box an electro-motor for operating the circuit making and breaking mechanism, and a stop for limiting the movement of the motor. (2) This invention embraces the advantage of an annunciator at a central office or any station operated automatically and instantaneously with the act of opening the door of the signal box. By said annunciator the number of the box from which the signal is sent is exhibited, thus apprising the firemen of the location of the fire at once, without waiting to hear the alarm bell strike the number.

396,961. Electrical Store Service Apparatus; R. N. Dyer, East Orange, N. J. Application filed July 1, 1887. In this system of store service apparatus electric motors run upon metallic tracks or rails from which the current is taken. A blade or grooved arm connecting with the motor opens down underneath the track and holds the carrier in suspension.

(1) 395,962. (2) 395,963. (1) Method of Manufacturing Electric Lamps; (2) Incandescent Lamp Filament; Thomas A. Edison, Menlo Park, New Jersey, Assignor of (1) to the Edison Electric Light Company, of New York, N. Y. (1) A high vacuum is produced in a globe of an incandescent lamp by placing within the globe a compound of chlorine or equivalent element, and then withdrawing the air from the globe. The filament of the lamp is heated to incandescence by an electric current during a portion of the latter step. (2) The process of preparing material for the manufacture of filaments consisting in volatilizing a substance having a high electrical resistance by electrically heating such substance in a vacuum, and causing the same to be deposited in the form of filaments as a sheet from which filaments are formed.

395,974. Electrical Measuring Apparatus; H. V. Hayes and A. C. White, of Boston, Mass. Application filed Oct. 27, 1888. The invention consists in combining a standard battery and a fixed resistance with a galvanometer, an adjustable resistance, and means for connecting the battery or appliance to be measured, and in graduating the adjustable resistance in such a manner that the value of the electromotive force of battery in volts may be read off from the figures annexed to such portion of the adjustable resistance as it may be necessary to introduce in order to bring the galvanometer to zero.

(1) 396,009. (2) 396,010. (3) 396,011. (4) 396,012. (5) (396,013. (6) 396,014, and (7) 386,015, respectively. Electric Welding; Elihu Thomson, Lynn, Assignor to the Thomson Electric Welding Co., of Boston, Mass. Applications filed, Feb. 21, 1887, May 21, 1886, May 15, 1888, May 17, 1888, Aug. 16, 1888, Oct. 8, 1888, and Oct. 12, 1888, respectively. (1) This invention affords a simple means whereby pieces of metal may be formed into any desired shape by the application of suitable dies or other tools while such pieces are heated by the passage of an electric current of large volume. (2) This is a method of utilizing the heating power of electric currents for forging operations in the nature of upsetting, whereby an enlargement is formed upon the ends or sides of pieces of metal. (3) This contemplates the function of a joint



395,773. CATHODE FOR AN ELECTRO-DEPOSITING APPARATUS.

between metals, and then, while maintaining the joint hot, hammering the same, and shaping it as desired. (4) This is a group of apparatus including a generator of electricity, a motor for driving the generator, clamps for holding the work and means for regulating the speed of the motor for purposes of regulating the volume of current. (5) This a method of joining pipe sections, wherein the abutting end of the pipe is formed with a taper or chamfer. (6) In this case a metal rod is heated for the purpose of stretching it at the point of fusion and reducing the cross section, or for the purpose of severing it entirely. (7) The invention consists in a method of riveting by placing the rivet or rivet blank in position in the socket, or where it is desired to rivet it, passing through the rivet an electric current of sufficient volume to heat the same to the requisite temperature, and then setting the rivet in its position by endwise pressure or other means employed in ordinary riveting operations. See illustration.

PATENTS EXPIRED JANUARY 28, 1889.

122,913. Burglar Alarm; C. C. Rowell and W. Duncan, Lebanon, N. H. The opening of a safe door breaks an electric circuit which operates an alarm within the safe.

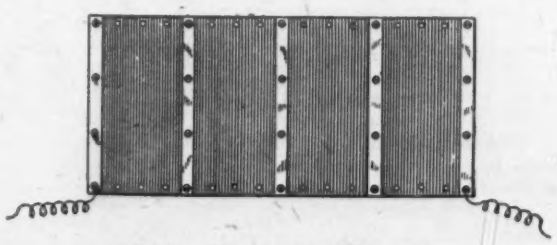
122,917. Truss; M. Schuppert, New Orleans, La. Upon this truss is fixed a bulb containing the battery elements and liquid. The current is carried through the iron frame.

122,944. Electro-Magnetic Engine; C. V. Gaume, Williamsburg, N. Y. Patented Jan. 23, 1872. Details of construction, which render the engine free from the "pull-back" or retardation noted in this kind of engines.

122,952. Telegraph Pole; R. D. McDonald and E. M. Crandal, Jersey City, N. J., and Marshalltown, Iowa, respectively. Patented Jan. 23, 1872. The lower section of the pole which enters the ground is provided with a winged supporting socket.

122,961. Telegraph Insulator; C. H. Pond, Cleveland, O. This is a wooden insulator covered with a metallic hood.

(1) 123.005. (2) 123,006. Printing Telegraphs; Thomas A. Edison, Newark, N. J. Patented Jan. 23, 1872. This



395,950. ELECTRICAL HEATING.

instrument is intended for a transmitting and receiving instrument. (1) When used as a transmitting instrument, a small magnetic motor, driven by a local battery, makes and breaks the main circuit, and the pulsations operate through a magnet in the transmitting machine, and also in the receiving machine or machines to rotate the type wheel by a step-by-step movement, and the type wheels hence move in harmony. When a finger key at the transmitting station is depressed the type wheel of that machine is stopped, when an arm upon its shaft comes in contact with the said key. This causes the simultaneous stoppage of the pulsations over the main line, arresting all the type wheels at the same point. The impression is now made simply in consequence of the pause that ensues, for the arm that operates the type wheel pawls closes the circuit of the transmitting instrument through its own printing magnet and the other printing magnet of the line, and the impression is taken. (2.) Relates to devices for moving the type wheel upon the shaft and thereby bringing one wheel into position for printing and throwing the other one out of action.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co. Ltd., Potter Building, N. Y.